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ON THE "GLASS-ROPE" HYALONEMA.

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(With a Coloured Plate.)

A BUNDLE of from 2- to 300 threads of transparent silica, glistening with a satiny lustre, like the most brilliant spun glass; each thread about 18 inches long; in the middle the thickness of a knitting needle, and gradually tapering towards either end to a fine point; the whole bundle coiled like a strand of rope into a lengthened spiral, the threads of the middle and lower portions remaining compactly coiled by a permanent twist of the individual threads; the upper portions of the coil frayed out, so that the glassy threads stand separate from one another, like the bristles of a glittering brush; the lower extremity of the coil imbedded perpendicularly in the middle of a hemispherical or conical undoubted sponge, and usually part of the exposed portion of the silicious coil and part of the sponge covered with a brown leathery coating, whose surface is studded with the polyps of an equally undoubted zoantharian zoophyte. Such is the general effect of a complete specimen of *Hyalonema Sieboldi* (Gray), a marvellous organism first brought to Europe from Japan, by the celebrated naturalist and traveller Von Siebold; and now to be found, more or less perfect, in most of the European Museums.

When the first specimen of *Hyalonema* was brought home, it stood in this peculiar position, that nothing had been seen in the least like it before, and the history of opinion as to its relations is curious. The being consisted of three very distinct parts:—first, and infinitely most remarkable, the twist of silicious needles; then the sponge, whose lower surface had evidently been attached to some foreign body, and which served as a sort of pedestal, from the top of which the flinty brush projected, spreading out above it in the water; and, thirdly, the apparently constant zoophyte. This complicated association suggested a multitude of possibilities. Was *Hyalonema* a natural

organism at all? Was it complete? Were the three parts essentially connected together? and, if not, were all the three parts independent? or, were two of these parts the same thing? and, if so, which two?

As my present object is merely to give a general sketch of the various attempts which have been made to solve this riddle, and to indicate the doubts and difficulties which still hinder its solution, while endeavouring, of course, to establish a harmony of opinion with my reader, I will trouble him as little as possible with technical details; nor do I feel called upon to work out the bibliography of the subject further than is necessary for my special purpose.

Hyalonema was first described and named in 1835, by Dr. J. E. Gray, who has since in one or two notices in the *Annals of Natural History*, and elsewhere, vigorously defended the essential points of his original position. Dr. Gray associated the silicious whisp with the zoophyte, and regarded the sponge as a separate organism. He looked upon the silicious coil as the representative of the horny axis of the sea-fans (*Gorgoniæ*), with which it certainly presented many analogies in minute structure, and the leather-like coat he regarded as its fleshy rind. He supposed, that between this zoophyte thus constituted, and the sponge at its base, there subsisted a relation of guest and host, the zoophyte being constantly parasitic in the sponge; and in accordance with this view he distinguished for the reception of the zoophyte, a new group of Alcyonarians, under the name of *Spongicolæ*, as distinguished from the *Sabulicolæ* (*Pennatulæ*) and the *Rupicolæ* (*Gorgoniæ*).

Dr. Gray's view seemed in many respects a natural one, and it was adopted, in the main, by Dr. Brandt of St. Petersburg; who in 1859, published a long memoir describing a number of specimens brought from Japan to Russia. Dr. Brandt illustrates fully the structure of this zoophyte, and refers it to a special group of sclerobasic zoantharians with a silicious axis.

In October last Dr. Gray published in the *Annals and Magazine of Natural History* an additional note on the "glass-rope" *Hyalonema*. While acknowledging his error in having referred the polyp incrusting *Hyalonema* to the barked Alcyonarians, an error of little moment if we admit the close relation of *Antipathes* to the typical zoantharia, the author adheres resolutely to his original view, and imagines that it has received full confirmation from the observations, hereafter to be noticed, of Senhor de Bocage; and in a short communication to the *Annals* for December, Dr. Gray alludes to a statement (which I can confirm) that the sclerobase of some *Gorgoniæ* contains silica. I will not at present dwell farther upon these papers,

as most of the points upon which Dr. Gray relies for the defence of his opinion are more or less fully discussed in these pages.

One consideration militated strongly against the hypothesis of Gray and Brandt. No known cœlenterate zoophyte had a purely silicious axis; and such an axis, made up of loose separate spicules, seemed strangely inconsistent with the harmony of the class. Silicious spicules of all forms and sizes, were conceivable in sponges; and in 1857, Milne Edwards, on the authority of Valenciennes, who was thoroughly versed in the structure of the *Gorgoniæ*, combined the sponge and the silicious rope into a single organism, and degraded the zoophyte to the rank of an incrusting parasite.

Anything very strange coming from Japan, is to be regarded with considerable distrust. The Japanese are wonderfully ingenious, and one favourite aim of their misdirected industry, is the fabrication of all kinds of impossible monsters, by the curious combination of parts of different animals. It was therefore quite conceivable that the whole thing was an imposition; that some beautiful spicules separated from some unknown organism, had been twisted into a whisp by the Japanese, and then manipulated so as to have their fibres naturally bound together by the sponges and zoophytes, which are, doubtless, rapidly developed in the Mongolian rock-pools. Ehrenberg, when he examined *Hyalonema*, took this view. He at once recognized the silicious threads as the spicules of a sponge, quite independent of the zoophyte with which they were encrusted; but he suggested that they might have been artificially combined into the spiral coil, and placed under artificial circumstances favourable to the growth of a sponge of a different species round their base.

The condition in which many specimens reach Europe is certainly calculated to throw some doubt on their genuineness. It seems that the bundles of spicules, made up in various ways, are largely sold as ornaments, in China and Japan. The coils of spicules are often stuck upright, with their lower ends in circular holes in stones. Mr. Huxley exhibited lately to the Linnæan Society a beautiful specimen of this kind, now in the British Museum—a stone has been bored, probably by a colony of boring Mollusks, and a whole family of Hyalonemas, old and young, are apparently growing out of the burrows; the larger individuals more than a foot in length, and the young ones down to an inch or so, like tiny camel's hair pencils. All these are incrusted by the usual zoophyte, which also extends here and there over the stone (glued on probably); but there is no trace of the sponge. Such an association, as we shall see hereafter, is undoubtedly artificial.

Professor Max Schultze, examined with great care several

perfect and imperfect specimens of *Hyalonema*, in the Museum of Leyden, and in 1860, published an elaborate description of its structure. I can entertain no doubt of the soundness of Professor Schultze's conclusions. The present sketch has been chiefly abstracted from his memoir, though I may add that I have lately had an opportunity of verifying his observations in almost every detail. The conical sponge, which forms the base of the fabric, I believe to be the body-mass of *Hyalonema Sieboldi*, a sponge allied to the genus *Alcyoncellum*, Quoi and Gaimard (*Euplectella*, Owen); and the silicious coil to be an appendage of the sponge, formed of modified spicules, and recalling in some respects the fringe of long calcareous styles surrounding the osculum in our common little *Sycon ciliatum*. The zoophyte is of course a distinct animal altogether, whose only connection with the sponge is that it is apparently almost constantly parasitical upon it. This style of association is not at all uncommon; take for example *Pagurus Prideauxii* and its attendant *Adamsia*, and especially *Palythoa axinellæ* (Schmidt), a constant parasite upon *Axinella cinnamomea*, and *A. verrucosa*, two Adriatic sponges.

On looking over Dr. Bowerbank's papers on sponges in the *Philosophical Transactions*, I at first took for granted that he adopted the views of Valenciennes and Schultze. In an answer which he published in the *Annals and Magazine of Natural History* for November last to Dr. Gray's paper, he, however, distinctly states that he has "always maintained that the silicious axis, its envelopment, and the basal sponge were all parts of the same animal." The polyps he regards as "oscula," forming with the coil a "columnar cloacal system." This view, I confess, I do not fully understand. At all events, Dr. Bowerbank thinks that the so-called "polypigerous crust" is a part of a sponge. That this position seems to me to be utterly untenable, my description of the *Palythoa* will sufficiently show.

In 1864, Senhor J. V. Barboza de Bocage, director of the Museum of Natural History of Lisbon, communicated to the Zoological Society of London the interesting intelligence that a species of *Hyalonema* had been discovered on the coast of Portugal, and in 1865 he published, in the proceedings of the same society, an additional note "on the habitat of *Hyalonema Lusitanicum*." It appears that the fishermen of Setubal, on the Portuguese coast, frequently bring up on their lines, from a considerable depth, coils of silicious threads, closely resembling those of the Japanese species, which they even surpass in size, sometimes attaining a length of about two feet. The fishermen seem to be very familiar with them. They call them "sea-whips," but, with the characteristic superstition of their

class, they regard all these extraneous organisms as "unlucky," and usually tear them to pieces, and throw them into the water. Senhor de Bocage has, however, succeeded in procuring several specimens, and one of these he has sent to the British Museum. This specimen I had an opportunity of examining, through the kindness of Dr. Gray. Judging from it and from Senhor de Bocage's figure, the "glass-rope" of the Portuguese form is not so thick as that of *H. Sieboldi*. I think there is some slight difference in the sculpture of the long needles, but I have not had an opportunity of making a minute microscopic examination of these. The thin (lower) end of the coil is entirely covered by the investing zoophyte, which extends uniformly over about two-fifths of the whole length. The polyps are oval, they project but slightly from the general surface, and are arranged regularly in spiral lines like the scars on the stem of a tree-fern. According to Senhor de Bocage, the granular appearance of the surface of the crust is not produced, as in the Japanese species, by agglutinated grains of sand, but by "an infinite number of club-shaped spicules bristling with points;" and, according to the same authority, "each polyp is supported by a silicious framework of filiform spicules, disposed longitudinally and at equal intervals on the internal wall of the body cavity." This latter point of structure is altogether peculiar, but in these and in other details *H. Lusitanicum* stands in need of the minute and careful study and illustration which it will doubtless receive from its discoverer.

Senhor de Bocage most accurately describes the mouth of the polyp as surrounded by a crown of not less than sixty minute, triangular, compressed tentacles, and justly suspects that the supposed difference in the number of tentacles between the Portuguese form and that described by Brandt might arise from an error of observation, depending, possibly, upon the bad condition of the specimens examined by the Russian naturalist. Although dead and somewhat dried up, in the specimens as procured by Senhor de Bocage the zoophyte was still soft, it had a strong fishy smell, and appeared to have been fresh when taken from the sea. No sponge-body has as yet been found in connection with any of the Portuguese specimens.

With regard to the essential nature of the organism, Senhor de Bocage leans to the view advocated by Gray and Brandt. He believes that as recovered from the deep by the Setubal fishermen it is homogeneous and complete. I have no hesitation whatever in expressing a most decided opinion that in this—as, indeed, in all such cases—the zoophyte is a parasite investing a coil of spicules which formed originally an

appendage of a sponge. The discovery at Setubal proves the interesting fact that a species of *Hyalonema* lives somewhere on the Portuguese coast, or, at all events, in the course of some one of the strong currents which wash the Lusitanic peninsula. The coil is hard, elastic, and insoluble—nearly indestructible. I believe that during the life of the sponge the *Palythoa* attaches itself to that portion of the coil just above the sponge body, and that after the disintegration of the sponge it creeps downward, naturally spreading towards that end of the coil where the spicules remain in contact.

The very fact that in *all* the Portuguese specimens the whole of the thin end of the coil is invested by the zoophyte, would suggest to me that the immediate neighbourhood of the coast of Portugal may not be the habitat of the *Hyalonema*, but that the isolated coils may have been gently drifted along the surface of the mud from a distance, and during a considerable space of time.

Hyalonema seems to be generally distributed. Dr. Leidy states that there is a small specimen in the museum of the Academy of Sciences at Philadelphia, said to have come from Santa Cruz.

I will now describe, a little more in detail, the structure and arrangement of the different parts of this singular sponge. The large silicious spicules form, as I have already mentioned, a brilliant coil, in large specimens upwards of a foot and a half long. The spicules on the outside of the coil stretch its entire length, each taking about two and a half turns of the spiral. One of these long needles is about one-third of a line in diameter in the centre, gradually tapering towards either end. The spirally twisted portion of the needle occupies rather more than the middle half of its entire length. In the lower portion of the coil, which is imbedded in the sponge, the spicule becomes straight, and tapers down to an extreme tenuity, ultimately becoming so fine that it is scarcely possible to trace it to its termination. Above, where the coil opens out, the spicule likewise becomes straight and tapers, but in all the specimens which have been examined the upper ends of the spicules have been broken off. The surface of the middle and lower portions of the spicule is perfectly smooth, but the upper part, where the coil is frayed out, has a frosted look, and feels rough to a finger drawn along it upwards. This roughness depends upon a series of little crest-like elevations, armed with minute teeth, which stretch about half way round the needle on alternate sides, at short intervals; or sometimes two of the crests unite into an irregular spiral ridge (Plate, Fig. 1).

Under the microscope, by transmitted light, the spiculum

throughout its entire length is minutely and delicately striated. These strise are not superficial, they indicate the edges of, or the intervals between, a series of extremely thin concentric silicious layers of which the wall of the spicule is composed. A distinct double line running down the centre marks the central canal, so characteristic of all sponge spicules. A transverse section, or an irregular fracture, shows distinctly the concentric silicious layers (Plate, Fig. 9). One point in connection with the central canal is important as establishing a relation between the spicules of the coil and those of the sponge-body. About the middle of the spicule, at its thickest part, the canal sends out two transverse branches, or sometimes four in the shape of a cross. These branches are extremely short, only displacing slightly a few of the inner silicious layers; the outer layers gradually resume their straight course, so that no bulging or distortion is to be seen on the surface of the thread, and the point, where the branching occurs, can only be discovered with difficulty by transmitted light, and with a magnifying power of 300 diameters. When the sponge is fresh, the spicules of the coil are covered from end to end with an organic film, and there are likewise films of sarcodic matter between the silicious layers. This can be shown by heating the spicule over a lamp, when the organic matter shows out brown by the separation of free carbon. The spicules are stiff, but somewhat elastic. When forcibly bent, and then freed, they instantly resume the spiral curve which was stamped upon them during their growth. The spicules on the outside of the coil are all of the same size and length, but in the interior they are shorter and finer, diminishing to an inch or so in length and to a hair-like fineness, so that new spicules are added to the coil from within.

In good-sized specimens the sponge-body is from five to six inches high, and about three inches in its widest diameter. The surface is shaggy with the ends of irregular bundles of spicules, and is closely dotted over with small round openings about a line across. Round each of these apertures there is a stellate arrangement of ridges, the ridges round one opening running into those round the opening next it, so as to cover the whole surface of the sponge with an irregular raised net-work. In the dried specimens from which, as yet, all our information is derived, these ridges, and indeed the whole substance of the sponge, consists simply of interwoven silicious spicules of various forms, with a mere trace of organic matter between them, cementing them loosely together. In most sponges with silicious spicules, the skeleton is partly made up of membranes, or threads, or granular masses of a horny substance. A net-work of horny fibres is the most common form,

and usually the spicules are scattered loosely among the threads, though in some cases the spicules are contained within the threads ranged along their centre. In all these cases the sarcodic living matter coats and surrounds both the threads and spicules. In some silicious sponges, however, the horny substance, in its firm condition, is entirely wanting, and the skeleton seems to be made up of silicious needles alone, with incrusting soft incoherent protoplasm. *Hyalonema* seems to be nearly in the latter condition, for a structureless film only, easily soluble in caustic potash or soda, coats and connects the spicules of which its framework is built up. The interior of the sponge is formed of a loose irregular network of threads of interwoven needles. Towards the base of the sponge there are several large irregular openings nearly half an inch wide, leading into passages lined by an open imperfect membrane of meshed spicules. Within the sponge these passages divide and pass into connection with a sort of lacunar system, which communicates with the round apertures opening externally on the surface of the sponge.

The lower end of the silicious coil penetrates the sponge vertically nearly to its base. After entering the sponge it becomes slightly thicker for an inch or so, and then rapidly diminishes to an extremely fine produced point. The needles of the coil are here intimately interwoven with the ordinary spicules of the sponge which pass in among them. The cord-like fibres of the sponge-mass flatten out as they approach the coil, and the so-formed irregular plates are felted as it were into the coil vertically between and upon its outer needles, so that the arrangement of the tissue of the sponge bears an evident relation to the position of the silicious axis.

The connection between the body of the sponge and the lower end of the coil is so close that considerable violence is necessary to separate them; indeed, it is absolutely impossible to do so completely without injuring the infinitely delicate ends of the long needles. This circumstance alone, although it may not be conclusive against the parasitical nature of the sponge, entirely disproves the artificial arrangement of the needles of the coil.

The form of the silicious spicules which build up the tissues of the body of the sponge is most varied. Most abundant, interlaced to form the great bulk of the threads of the spongy texture, and accumulated especially towards the surface, are long spindle-shaped needles about a line in length. These spicules (Plate, Figs. 4 and 5) are frequently smooth, and pointed at both ends; but sometimes one end is pointed and the other clubbed, and very frequently either one end or both ends, or the whole length of the needle, is studded with short

pointed projections, usually turned towards the point of the needle, rarely bent backwards like barbs from either end towards the centre. In all these awl-shaped spicules a delicate central canal is very apparent, and, in all of them, at or near the middle of their length, one or two fine cross canals cut the central canal at right angles, exactly as in the long needles of the coil. When the cross canals have an appreciable length, two or four slight bulgings on the outer surface of the needle indicate their position (Plate, Fig. 5).

From this form we pass by an easy transition to a second class of very generally distributed spicules. In cases where a single cross canal only is developed, this canal has become produced into two arms at right angles to the original spicule, and the primary and secondary branches together form a cross (Plate, Fig. 8). When two transverse canals are produced, a star of four secondary branches cross the main shaft, giving origin to the remarkable six-spoked forms (Plate, Fig. 6). The larger of this group are usually nearly smooth, but very minute spicules of the same type, with all the branches feathered and their ends curved (Plate, Fig. 10), are very common, clustering in groups round the larger styles. Frequently one of the halves of the needle is undeveloped, and a form is produced in which the single long shaft, representing one half of the original spicule, stands out from a whorl of four transverse branches; all the rays are feathered. Such spicules line in large numbers the internal cavities and passages of the sponge. The cross is placed against the bounding felt of spicules, and the long barbed ray projects into the space, apparently to prevent the entrance of foreign matters (Plate, Fig. 2).

The most remarkable spicules are the two forms represented in Plate, Figs. 3 and 11. The larger of these (Plate, Fig. 3) consist of a strong shaft roughly tuberculated, with a well-marked central canal showing the characteristic cross processes. From either end of the shaft from seven to nine long teeth curve gracefully backwards, ending nearly opposite the centre of the shaft in fine points. These singular spicules are most abundant in the cortical layer, though they are found likewise scattered irregularly through the substance of the sponge. The other set (Plate, Fig. 11) are exceedingly minute, only to be detected by a power of about 300 diameters; they resemble those just described in general form, but the recurved hooks are united by a kind of silicious web, beyond which the point of the hooks project slightly, so that the expanded ends of these spicules are singularly like umbrellas. They resemble most remarkably in form and size the "amphidisci" of the gemmules of *Spongilla*; they are not,

however, found in connection, but are scattered along with the small cross spicules (Fig. 10) in great numbers throughout the whole of the sponge substance. Many spicules of the awl-shaped and simple cross types, especially short spicules, represented in Fig. 7, are met with within the silicious coil to its very centre, and, in cases where the coil has been brought home without the sponge, such needles can be shaken out from the interstices of the threads. The spicules of *Hyalonema* are marked in their character, and all the forms described above are found in all specimens of the sponge imbedding the characteristic bundle of enormous spicules; so that there can be no reasonable doubt of the specific identity of the sponge in all cases.

Within the round apertures on the surface of the sponge there is usually a brownish orange-coloured membrane. At first sight one would never dream of doubting that this membrane forms part of the sponge, but, on examining it with a high power in order to make out its minute structure, Professor Schultze found, to his surprise, that it presented the marked characters of a polyp tissue; in fact, that it was the remains of a minute parasitic polyp, probably alcyonarian, which inhabited the oscula and their passages during the life of the sponge. The thread cells of the polyp membrane are quite distinct, and it has even been possible to isolate entire extremely minute fringed tentacles, richly clad with almost linear thread-cells.

The view adopted by Gray and Brandt, that the silicious coil is the axis of a zoantharian zoophyte allied to the *Antipathes*, is founded upon the circumstance that the coil of silicious spicules is almost always coated to a greater or less extent, by a dark leathery layer, studded with the projecting bodies of true polyps. The outer surface of the investing layer is rough with included particles of sand, shells of foraminifera, and sponge spicules, chiefly those of *Hyalonema*, and these spicules usually become very numerous in the polyp layer in the immediate neighbourhood of the body of the sponge. Beneath this layer, with its contained foreign bodies, there is a thick band of a nearly transparent matrix, with scattered, oval, yellowish, granular masses. Within these ovals are imbedded very characteristic groups of thread-cells, oval, half filled with granules, and half with a delicate, spirally-coiled thread. Such thread-cells are generally distributed throughout the cœnosarc, and in the walls of the polyp bodies. A third, loosely-areolated, thin layer grasps closely the surface of the silicious threads. Some doubt arose at first whether this third layer belonged to the zoophyte or to the sponge. It most likely forms the basement membrane of the cœnosarc of the

former, as a still thinner membrane, with a somewhat stellate arrangement of its substance, can sometimes be detected beneath it, and spreading along the large spicule beyond the portion incrusted by the zoophyte. This, the most delicate of all the investments, very probably consists of a dried-up layer of sarcodic sponge matter.

I have lately dissected carefully the species or variety of *Palythoa*, which gives its peculiar character to Brandt's *Hyalochæta Possieti*. In this species the projecting polyps are cylindrical, and in some cases about a line in length. In their retracted state, they show a small round opening in the centre of a mammillary projection, the opening surrounded by about twenty obscure radiating lines. When softened by being steeped in dilute acetic acid the polyps become quite plump, and are almost as easily examined as if they were fresh. The external body-wall consists as usual of two layers, of which the outer is thickly coated with imbedded grains of sand. In the specimen I last examined, I could not detect in this layer a single characteristic spicule of *Hyalonema;* fragments only of linear needles were mixed here and there with the sand. In other specimens, however, I have found the surface crowded with *Hyalonema* spicules; but I am confident that in these cases they were embedded simply as grains of sand, or any other foreign bodies might have been. The peristomial space contains a crown of at least sixty tentacles, in three alternating rows, those of the outer row the larger. The tentacles are short and conical, with the peculiar curve which is characteristic of *Zoanthus* and its allies; rather large oval thread cells are scattered sparingly in their walls.* The digestive sac is fluted and corrugated, and its upper portion only is attached to the body wall by about twenty membranous mesenteries. There is no trace of spicules, either silicious or calcareous, in the inner layer of the body wall, in the wall of the stomach, or in the mesenteries.

There seems to me to be no character whatever to separate this zoophyte from the well-known zoantharian genus *Palythoa*, to which, following Professor Schultze, I have already referred it. I have not yet had time to examine many specimens with due care, but my present impression is that we are acquainted with three species of *Palythoa* incrusting the coils of two species of *Hyalonema* — 1. the *Palythoa* with round, depressed, irregularly-arranged polyps, parasitical upon most of the specimens of *Hyalonema Sieboldi* from Japan;

* The crenated tentacle figured by Schultze (Taf. 5, Fig. 4) is not that of *Palythoa*, as stated by Dr. Gray (*Ann. and Mag., Nat. Hist.*, Oct. 1866), but is a tentacle of the minute Alcyonarian parasite, which Professor Schultze detected within the pores and passages of the sponge.

2, the form with produced polyps, investing the same species, and distinguishing *Hyalochæta Possieti* of Brandt; and, 3, the species with oval polyps more regularly arranged, which seems to be constantly associated with *Hyalonema Lusitanicum*.

Such is an outline of the structure of *Hyalonema*, so far as it can be made out from dried specimens. After the careful microscopic observations of Schultze, I think there can be no doubt whatever that the silicious coil and the sponge form one organism. Perhaps the most conclusive proof of this is the essential correspondence in structure and plan of growth between the long spicules of the coil and the spicules of the body of the sponge; and the peculiarity of that mode of growth distinguishes *Hyalonema* from most other sponges. Since Professor Schultze's memoir was written, many additional specimens have been brought to Europe. All of these, so far as I know, are in the same dried and partially mutilated state. I saw, I should think, nearly a hundred in London last year. Most of them had lost all traces of the sponge, and almost all were coated through the greater part of their length with *Palythoa*. The zoophyte was often continued quite down to the lower end of the coil, which in all these cases was more or less truncated and injured. Many of the specimens had the egg-bags of a small shark or dog-fish attached to them. From the appearance of all I have little doubt that the coils had first of all got disengaged from their investing sponges by the decay of the sponges or by a storm, and that afterwards the *Palythoa*, and other animals and plants, attached themselves to the free coils lying between the rock-pools or between tide-marks.

The two specimens figured in the woodcuts are among those in the Museum of Queen's College, Belfast. In one of these (Fig. 1) the thin end of the coil is entirely coated with the incrusting zoophyte. The polyps stand out considerably from the general surface of the crust, and here and there the cœnosarc and the polyps run together into irregular, projecting, knob-like masses. This specimen must clearly be referred to the form named by Brandt *Hyalochæta Possieti*, indeed, it closely resembles the specimen from which Brandt's figure was taken. One of the terminal polyps has been broken off, and the truncated, somewhat worn end of the coil has been thus exposed. As the thin end of the coil is always uncovered by the zoophyte when it is inserted into and connected with the sponge, and as the coil could not possibly have been poised in the sponge without any attachment, and in its present condition, it is evident that in this case the "polypigerous crust" must have been extended over the end of the coil after

the latter had become separated from the sponge. Admitting this, the zoophyte must have grown over the lower end of the coil as it might have grown over any other foreign body, and this appears to me to be totally inconsistent with the idea that the coil was originally secreted as an axis by the same animal.

In the other specimen (Fig. 2), both ends of the coil have been frayed out, probably by long drifting in shallow water. The *Palythoa* occupies the central portion, and in extending in both directions it has coated several of the individual spicules. Some of these are uniformly incrusted by the arenaceous layer, the polyps standing out at intervals. This can be explained by no mode of branching of which we have any experience. In *Gorgonia* or *Antipathes*, as in most other branching organisms, a young branch is a repetition of the early development of the stem from which it springs. A branch of *Hyalonema*, were this an animal or a colony capable of branching, would undoubtedly contain as its axis a fascicle of growing needles.

A week or two ago, Dr. Gray received at the British Museum two specimens of the Japan *Hyalonema*, which appear to me to be highly instructive.

I was in the Museum when they arrived, and Dr. Gray, with characteristic generosity, placed them at my disposal for examination, before he had even had time to look at them carefully himself. In one of these the basal sponges was uninjured. No trace whatever of the *Palythoa* was to be seen on the coil.

It is well known that the Japanese often strip off the crust to improve the appearance of their specimens. There are few things more fragile or more offensive than a loosely meshed silicious

Fig. 1.

Fig. 2.

sponge in its fresh state, and it is very unlikely that where the bark was so thoroughly removed, the sponge should have been saved. In the other specimen the sponge was wanting, but the lower part of the rope was well coated with *Palythoa*. Into and through its crust were twined and twisted the suspending cords of the egg of a dog-fish, and in several places the indiscriminating zoophyte had erred from the glassy coil, and coated with a uniform and impartial layer, the cords of the dog-fish's egg!

The glassy whisp of *Hyalonema* is certainly very remarkable, but it is not entirely without analogy. *Hyalonema* seems to represent the extreme form of a little group of sponges, including, with probably a few other known forms, *Euplectella* (*Alcyoncellum*) *speciosa* (Quoi and Gaimard), and *E. cucumer* (Owen). The latter of these is an oval sponge, with silicious spicules whose form is somewhat analogous to that of the spicules of *Hyalonema*. From one end of the sponge a tuft of long silicious threads, resembling in structure those of the Japan sponge, twine round a stone, or other foreign body. Dr. Bowerbank isolated one of these spines of *Euplectella*, three inches long.

DESCRIPTION OF THE PLATE.

Fig. 1. *Hyalonema Sieboldi* (Gray), from a specimen in the British Museum.

Fig. 9, fragment of the upper part of one of the large needles of the coil; Figs. 2—8, 10, various forms of spicules.

THE STAR CHAMBER: ITS PRACTICE AND PROCEDURE.*

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THE only complete treatise on the practice and procedure of the Court of Star Chamber which has come down to us was written by William Hudson, Barrister, of Gray's Inn, who practised in the court. Hudson did not publish his book, having, probably, before his eyes the terrors of a tribunal that fined, without respect to the *salvo contenemento* clause of the great charter, all who spoke "with great severity against it," and which "sometimes invented punishments in some new manner for new offences." So wholesome a fear had the author of his subject, that even in the manuscript (which he did not mean to publish) he declined to discuss the nature of the jurisdiction of the court. "I will not," he says, "dispute *de jure et de facto*, but declare, as briefly as I can, what matters are there usually determined." Hudson left the manuscript to his son, who gave it, as appears by a note appended to it, to Chief Justice, afterwards Lord Keeper, Finch, on the 19th December, 1635. The book was first printed and published in 1791–2, in the *Collectanea Juridica*, two volumes of *Tracts relating to the Law and Constitution of England*. The original manuscript is No. 1226, vol. i. of the Harleian MSS. From the printed copy in the British Museum the following particulars relative to the Court of Star Chamber have been chiefly drawn.

As to the name of the court, Hudson says it was not derived from the ornaments of the room in which the sittings were held. He says, "I suppose the name to be given according to the nature of the judges thereof"; and to explain what he means, he talks some nonsense about the judges being stars who shine by the light reflected from the king, the sun of their system. He further says, that the name could not be derived from the ornaments, for they were in the room because they were the device on the seal of the court. Content with

* 1. *A Treatise of the Court of Star Chamber.* By William Hudson.

"This treatise was compiled by William Hudson, of Gray's Inn, Esquire, one very much practised and of great experience in the Star Chamber, and my very affectionate friend. His son and heir, Mr. Christopher Hudson (whose handwriting this book is) after his father's death gave it to me, 19 December, 1635.

"JO. FINCH."

(Lord Keeper—temp. Chas. I.)

2. *An Essay upon the Original Authority of the King's Council.* By Sir Francis Palgrave, K.H. Published by the Record Commissioners, 1834.

this derivation of the name, Hudson goes on to show how ancient a name it was, and quotes from a complaint made in 40 Edward III., by Elizabeth Studley on account of some wrong done to her by James Studley, upon which James Studley was ordered to appear before the Chancellor and other lords of the council, assembled in "*le chambre de estioles pris de la receipt*" (Exchequer) at Westminster.

The name has been derived from the Saxon steoran, "to steer or govern;" and also from the *crimen stellionatus*, "cozenage," which the court punished; whilst Blackstone suggests the most reasonable origin of all when he observes that before the banishment of the Jews from England by Edward I., the Jewish covenants or contracts were called *starra* or *starrs*, a corruption of the Hebrew *shetàr*. These covenants were, by an ordinance of Richard I., directed to be enrolled and kept in chests under three keys, in certain places, one of which was the Exchequer at Westminster; and no starr was valid unless it could be found in one of these depositories. The room in which they were kept in the Exchequer was probably called the "starr" chamber; and Blackstone suggests that when the Jews were driven out, their covenants were destroyed, and the room in which they had been kept was appropriated to the use of the Privy Council. Sir Francis Palgrave, in his *Essay on the Original Authority of the King's Council*, says, "When Parliament assembled at Westminster, some of the principal chambers of the ancient and splendid palace were allotted for the despatch of business. The Commons sat in the Chapter-house of the adjoining abbey. But the Painted Chamber, the White Chamber, and the Chambre Markolph—probably so-called from the legendary tale relating the trials to which the wisdom of Solomon was subjected by a Syrian peasant, depicted on its walls—were occupied by the triers and receivers of petitions. The council itself, whether 'Parliament' was assembled or not, held its sittings in the 'Starred Chamber,' an apartment situated in the outermost quadrangle of the palace, next the bank of the river, and consequently easily accessible to the suitors, and which at length was permanently appropriated to the use of the council."

It has been a common error to date the foundation of the Star Chamber from the third year of Henry VII. Even Lord Andover, who, in 1640, had charge of the bill which passed into "an act for regulating the Privy Council, and for taking away the court commonly called the Court of Star Chamber," erroneously referred to 3 Henry VII. c. 1, as the statute which had first founded the court. "This," he says, "was the infancy of the Star Chamber. But afterwards the Star Chamber was, by Cardinal Wolsey, in the 8 Henry VIII.,

raised to man's estate, from whence (being now altogether unlimited) it is grown a monster." The truth is, the statute of Henry VII. was the first statute that recognized the existence of the Star Chamber, and conferred upon it judicial power; but the court or council, or both in one, existed long before Henry's reign. If we go to the length Hudson does, we shall have to believe what he certainly suggests, that the Star Chamber was "the council" referred to when a man was told that he stood "in danger of the council" for saying to his brother "Raca." But without carrying the matter quite so far back, it will be found that in Edward the First's time distinct mention is made of the Star Chamber, which appears to have exercised the mixed functions of a judicial and governmental council. At this time it was composed of the chancellor, the treasurer, the justices of either bench, the escheators, serjeants, some of the principal clerks in Chancery, "and such others—usually, but not exclusively, bishops, earls, and barons—as the king thought fit to name." Palgrave says: "On certain occasions it appears that the official members sat and acted alone; but that on others they were united to the rest." This council is the same body which is alluded to in very many statutes subsequently to Edward I. as that before which offenders in certain cases are ordered to appear, and by some of which authority is given to the "King's Council" to do certain things. Hudson says, when ridiculing the notion that his favourite court was established by the statute of Henry VII., that it is "a doating which no man that hath looked upon the records of the court would have lighted upon."

In order rightly to understand the constitution of the court, and to trace the source whence it derived its authority, it should be remembered that there were three councils known, in practice at least, to the English law—the Commune Concilium, the Magnum Concilium, and the Privatum Concilium. Of these three, the first was the general assembly of the military tenants of the crown, answering to the House of Lords of to-day; the second was that large committee of the first to which the king looked for advice in his government, and to which he referred petitions and complaints made to himself; the third was a select committee of the second council, supplemented by certain judges and serjeants, who sat as assessors. To this select committee were sent, in the course of time, not only all questions as between subject and subject, which had been submitted by petition to the king, or his Magnum Concilium, but also all complaints—and they seem to have been pretty numerous—of misconduct and injustice on the part of the royal officers. If the second council may be said to have borne to the first the same relation that the Privy Council now

bears to the House of Lords, the third council may be said to have borne to the second a relation somewhat similar to that which the Judicial Committee of the Privy Council now bears to the Council itself.

From hearing complaints upon petition, to instituting proceedings on its own account, whether by causing the Attorney-General to bring informations against particular persons before it, or by summons under the privy seal, was neither a long nor a difficult stage in the progress of the court; and we find—the troublous times of Henry VI. favouring the growth of excesses of all kinds—that in the reigns of Henry VI. and Edward IV. the select committee of the Privy Council, while discharging those judicial functions of the council which it derived from the parent council, the House of Lords, arrogated to itself a power in criminal causes which was often beneficially exercised, but was too unbounded not to tempt the wielders to abuse it.

A glance at the headings of many of the earlier statutes, a cursory glance at the roll of the Exchequer, will show the crying need there must have been for some supreme and powerful judicial arm to overawe the passions of vindictive officers acting in the king's name, and to counteract the widespread disease of the "itching palm," which caused the judges to sell, delay, and pervert justice. The fact that statutes were passed against judicial crookedness and rapacity, is proof enough that such crookedness and rapacity existed; and when we find entries on the roll of the Exchequer of so many hens, of a butt of wine, of money given to the king that the giver might "have justice," we are tempted to ask, Who guarded the guardians of the right? The 52 Henry III. (the statute of Marlbridge) c. 11, forbids the payment of a fine to the judge to induce him to grant a fair hearing; the statute of Westminster the First, 3 Ed. I. c. 25, forbids the clerks of the court to encourage litigation for the sake of the court fees; the 38 Ed. III. st. i. c.12, provides a punishment for jurors who take bribes; the 20 Ed. III. st. iv. c. 1 and 2, prohibit the judges from taking fees, or giving counsel in suits to which the king is a party; and there are others of a like nature here and there in the statute-book, down to the 3 Hen. VII. c. 1, which last act shows in its preamble the necessity that still prevailed for curbing judicial wickedness in high places.

The statute 3 Hen. VII. c. 1, is called *An Acte geving the Court of Star Chamber authority to punyshe dyvers mysdemeanors.* It recites that "the King our Sovereign Lord remembereth how, by unlawful maintenance, giving of liveries, signs, and tokens, and retainers by indenture, promises, oaths, writing or otherwise, embraciaries of his subjects, untrue

demeaning of sheriffs in making of panels, and other untrue returns, by taking of money by juries, by great riots and unlawful assemblies, the policy and good rule of this realm is almost subdued"; and then goes on to ordain that "the Chancellor and Treasurer of England for the time being, and the Keeper of the King's Privy Seal, or two of them, calling to them a bishop and a temporal lord of the King's most honourable Council, and the two Chief Justices of the King's Bench and Common Pleas for the time being, or other two justices in their absence, upon bill or information put to the said Chancellor for the king, or any other, against any person for any misbehaving afore rehearsed, have authority to call before them, by writ or privy seal, the said misdoers; and them and others by their discretions to whom the truth may be known to examine; and such as they find therein defective, to punish them after their demerits, after the form and effect of statutes thereof made in like manner and form as they should and ought to be punished if they were thereof convict after the due order of the law."

The reasons why such a court as the Star Chamber should exist, and the sort of authority Parliament intended to give it, are thus set forth, at the same time that it is evident the power conferred by the act is given to a court already in existence, and specially described as "the Court of Star Chamber." Lord Bacon, writing of the Star Chamber, says: "This court is one of the sagest and noblest institutions of this kingdom. For in the distribution of courts of ordinary justice, besides the High Court of Parliament, in which distribution the King's Bench holdeth the pleas of the crown, the Common Pleas pleas civil, the Exchequer pleas concerning the king's revenue, and the Chancery the pretorian power for mitigating the rigour of law, in case of extremity, by the conscience of a good man; there was, nevertheless, always reserved a high and pre-eminent power to the King's Council in causes that might, in example or consequence, concern the state of the commonwealth, which, if they were criminal, the council used to sit in the chamber called the Star Chamber; if civil in the White Chamber, or Whitehall. And as the Chancery had the pretorian power for equity, so the Star Chamber had the censorian power for offences under the degree of capital. This court of Star Chamber is composed of good elements, for it consisteth of four kinds of persons—counsellors, peers, prelates, and chief judges. It discerneth also principally of four kinds of causes—forces, frauds, crimes various of stellionate, and the inchoations or middle acts towards crimes capital or heinous, not actually committed or perpetrated. But that which was principally aimed at by this act was force, and the two chief

supports of force, combination of multitudes, and maintenance or headship of great persons."*

Up to the time when, as Palgrave says, "the Star Chamber raged with savage vigour for the punishment of mere political offences," it would not seem that the court had drawn any great amount of odium to itself by acts of tyranny done in the name of justice. There were, now and again, complaints made that the council took notice of causes which ought to be tried at common law; but, on the whole, the court had worked for the public good, discharging some of the functions which are now exercised by the courts of Chancery, Queen's Bench, Admiralty, and Probate, and constituting, in criminal matters, a kind of court of conscience, administering justice rather according to the particular circumstances of the case than the law of it, and having the advantage of freedom from the forms and trammels of the common law procedure. It could adjourn a case for further evidence, which a law court could not; it could examine and cross-examine the principals in a cause civil or criminal, and it was entirely free from the highly technical system of pleading which often worked injustice in the common law courts. Whether a civil and a criminal court, erected out of distinct committees of the Privy Council, sat at the same time and by virtue of the same authority, as Lord Bacon would seem to suggest, is a question involved in much obscurity; but it is at least not irreconcilable with his statement to suppose that the same members of the Privy Council discharged both the civil and criminal functions of that body, only changing their place of meeting according to the business

* It is but right to state what that great father of English law, Sir E. Coke, who was to Francis Bacon what the Chief Justice of to-day is to the youngest barrister that is "sure to make his way," says on the subject of the Star Chamber.

Sir E. Coke (*Institutes*, Part 4, c. 5) begins by showing out of the Rolls of Parliament and Year Books the nature of the cases triable in the Star Chamber. These are identical with those set forth in the present paper. He then says that formerly the Court sat rarely, because it was not often that flagrant occasion was given for its interference; and because then it did not meddle with causes which the other Courts were competent to try. He goes on to show that the statute of Henry VII. did not originate the Court of Star Chamber, and claims to the credit of the Court that it dealt with offences "especially of great men," . . . . . "to the end that the medicine may be according to the disease, and the punishment according to the offence."

Sir E. Coke says the Court is named of "Star Chamber" because "the roof is starred." He explains the holding of the Court *coram rege et concilio* to mean,

1. Before Lords and others of his Majesty's Privy Council.
2. Before the Judges of either bench, and the Barons of the Exchequer.
3. Before the Lords of Parliament, who however were not standing Judges unless they were also Privy Councillors.

And he had so high an opinion of the Court that he says, "It is the most honourable Court (our Parliament excepted) that is in the Christian world, both in respect of the Judges of the Court, and of their honourable proceedings according to their just jurisdiction, and the ancient and just orders of the Court."

they had to transact. Sir Francis Palgrave, however, would appear to think that the criminal jurisdiction of the Privy Council was alone vested in the Court of Star Chamber, the jurisdiction in civil causes being retained by the body of the council. For, after stating that the statute of Henry VII., which declared the authority of the court, and the 21 Henry VIII. c. 20, which added the President of the Council to the other members, "virtually created the Court of Star Chamber as it existed under the Tudors," says: "The Privy Council, sitting as such at Whitehall and Greenwich, gradually abandoned its criminal jurisdiction to those of its members who assembled at Westminster, conjointly with the justices of either bench, and under the direction of the Lord High Chancellor." Though it is quite likely that the Privy Council reserved to itself the right to hear any complaint which might be brought before it, notwithstanding it had delegated so much of its judicial power to its committee—a right which privy counsellors sometimes questionably claimed to exercise by taking their seats at the board in the Star Chamber, though they were not regular members of that court—it is certain the council, as such, did not, at least under the Tudors and the Stuarts, habitually sit as a court of appeal or as a court of first instance. Whatever the theory might have been, the practice was, since the declaratory act of Henry VII., for the Star Chamber to discharge both the criminal and civil business of the council. It will be as well here to ascertain what power was actually wielded by the Star Chamber, what the procedure in the court was from summons to execution, and then to indicate the causes which led to its ruin.

The Court of Star Chamber had jurisdiction both in civil and criminal causes, and could enforce its sentences by any punishment short of death, and dispossession of freeholds. Even these two extreme punishments it was able to inflict by indirect means, as will be shown later on.

As a court of civil law, it entertained suits by the king's almoner for the delivery of deodands, and the goods of suicides, felons, etc. It also took cognizance of "great matters of interest betwixt the king and his subjects, which are accompanied with conveniency of state as well as *meum and tuum*." One large branch of its practice lay in the hearing of causes against corporations, abbeys, great lords, and others whom it was difficult to reach through the common channels of the law. It was a reason very frequently given for applying to the council that the defendant was a person of so great influence that a fair trial could not be had at common law. Alien merchants, women who had been cheated of their jointure, suitors in testamentary matters, in prize claims, in actions for

collisions at sea, and the people of Jersey and Guernsey, appeared as parties to actions in this court. No other means of redress were available for them, and so long as the Star Chamber furnished the means, it was doing good service, and no one felt disposed to question too closely the soundness of its jurisdiction.

Whenever a question arose involving the title to a freehold, the practice of the court was to send the issue to be tried in one of the common law courts, and when the return was made to proceed with the cause to which such question had been incidental. As a court of appeal, it does not seem to have done much, though theoretically an appeal lay to it from the courts of the Wardens of the Marches, the courts of the Stanaries, and those of the counties Palatine; and there are instances recorded of writs of *certiorari* addressed to these courts, ordering cases which had been brought before them to be transferred to the Court of Star Chamber.

As a criminal court, the jurisdiction extended to "cases which in strictness of law cannot be otherwise questioned, and may be here examined"; causes of special limitation by Act of Parliament; and causes which were also cognizable by the courts of common law. The way in which the court laid hold of offences of the class last mentioned may be best stated in Hudson's own words. He says: "Being now to treat of criminal causes I must begin with the highest, and therein I shall show that all offences may be here examined and punished, if it be the king's pleasure, as treason and murder, felony and trespass; but then are not all these offences punished as trespasses, and not capitally; for if it please the king to remit his justice, and yet not so that the world shall have notice of the offence, he may call a traitor to this bar, and take acknowledgment, and fine and ransom him." Thus it was under a show of mercy, of a desire to mitigate the severity of the law, without setting the law aside, that cases which were properly triable at common law, were brought into the Star Chamber; and the benefit supposed to accrue to a man in consequence was deemed to outweigh the disadvantage of trial by persons who were not his peers, nor sworn to do justice in his particular case. Hudson is of opinion that this last was very far from being a disadvantage, for he says, "subjects may as safely repose themselves in the bosoms of those honourable lords, reverend prelates, grave judges, and worthy chancellors, as in the heady current of burgesses and meaner men, who run too often in a stream of passion after their own or some private man's affections." The tender considerations of the prince for his erring subjects, his refusal even at the cost of violations of the constitution, to hand them over to condign

punishment, which would only have the effect of hardening or destroying them, are ingeniously put by the apologist of the court; but though there might be some ground for this assertion with reference to Plantagenet times—but then the criminal jurisdiction of the Star Chamber was not developed—people will not be disposed to give the princes of the House of Tudor still less of the House of Stuart, credit for so much disinterestedness and exalted virtue. They will, it is to be feared, rather think that the power to "take acknowledgment, fine, and ransom," of people who else would be destroyed or imprisoned at the king's expense, for their offences, was the reason why common law offences should have been drawn into the Star Chamber. As a matter of fact this was so. Empson and Dudley set the hateful example of exacting enormous fines under colour of a judicial sanction, which was not based upon any known rule of law, but was dictated by the caprice of the judge or the emptiness of the exchequer at the moment. Though these men were punished for their temerity, their example had many imitators. Ruinous fines were inflicted for offences perfectly venial, without any regard to that clause of the Great Charter, which forbids the imposition of such a fine as will disable a man from earning his livelihood. Even Hudson speaks of the fines as "trenching to the destruction of the offender's estate, and utter ruin of him and his posterity."

The causes which "in strictness of law cannot be otherwise questioned, and may be here examined," included forgery, perjury, riot, maintenance, fraud, libel, and conspiracy. The perjury was not merely that committed by a witness *coram judice*. For such an offence punishment was provided by 5 Elizabeth c. 9, which inflicted a fine of twenty pounds, or in default sentenced the delinquent to the pillory and nailing of both ears. In considering punishment, the Star Chamber acted analogously to the statute, but extended its authority very much further. It punished perjuries committed by jurymen, who gave a verdict against the evidence, or sold their verdict, or did anything which the Star Chamber, judging of fact, law, and punishment, deemed to constitute perjury; and this last came to mean that any jury which had given a verdict contrary to what the court thought should have been given, was "in danger of the council." There are many instances of heavy fines imposed upon juries, one of the most celebrated being that of the jury in 4 and 5 Philip and Mary, which acquitted Throckmorton of treason, upon evidence which the Star Chamber thought sufficient to warrant a conviction. The jurors were imprisoned, and some of them attempting to justify themselves before the council, were fined in sums varying from two thousand pounds to a thousand marks each. Other

cases there are in abundance, but Hudson's words are conclusive to show the practice of the court toward those whom it considered to have broken their oaths to "well and truly try, and true deliverance make." He says, "And in the reigns of Henry VII., Henry VIII., Queen Mary, and the beginning of Queen Elizabeth's reign, there was scarce one term pretermitted but some grand inquest or jury was fined for acquitting felons or murderers." In this way the Star Chamber which refrained from sentences of death, sometimes intimidated juries into verdicts which were against their consciences and their oaths, for it was not often a jury made such a stand as that which acquitted Sir Nicholas Throckmorton. But before condemning wholly the practice of the court in regard to juries, it will be as well to ascertain whether there was any ground on which its practice might rest, and very little search will prove that there actually was such ground. Hudson cites a number of cases in which the jury had been "laboured" beforehand, and gave their verdict without regard to the evidence; but a less partial witness than he, Sir Francis Palgrave, in his treatise on the Privy Council already quoted, says, "trial by jury has been, and may be, so affected by the general position of society as to become an active instrument of mischief and oppression. Trial by jury may now be called a tribunal composed of the peers of the defendant or of the accused. It has become so, at least in theory, by the alteration of the law, which allows the jury to be the judges of the truth of the evidence given before them, but this practice is comparatively recent, and engrafted upon the ancient institution." The jurors in former times were in fact the witnesses, being summoned for the very reason that they knew or were supposed to know, about the facts in the cause to be tried. The sheriff was bound to summon such persons whose knowledge was often derived from no more than mere gossip, the hearsay of the village or the district. Jurors with minds already prejudiced, or so well informed upon the facts of the case as to allow of prejudices previously entertained having play, were the triers; and it is not remarkable that they often arrived at verdicts both improper and untrue. In much later times the difficulty has been experienced of procuring the only verdicts warranted by the evidence — *e. g.*, Welsh juries—imbued with local or national sympathies, and when the potency of such sympathies in remote ages, coupled with the constitution of the juries as already described is taken into consideration, one is able to see at least a possible need for the interference of the council in order to keep clean the fountains of justice. In the 33 Edward I., the king and council agreed upon a definition of "conspiracy," which was intended to include jurors. Those who bound themselves

"by oath, covenant, or alliance, that each will aid and sustain the other in falsely and maliciously indicting or causing to be indicted, *or in falsely acquitting*, or in raising and maintaining any false plea," were to be deemed conspirators. The courts of law, however, held that jurors were not within this definition, and the evil which the king and council intended to remedy, remaining unabated, the sovereign arm was kept stretched out until the evil having disappeared, while the remedy grew ever more powerful, it became itself to be an unbearable nuisance. But originally this was not so. Besides taking notice of perjury in the common law courts, the Star Chamber punished the same offence when committed in the Ecclesiastical, Stannary, and Chancery courts.

Riot included unlawful assemblies, forcible entries and detainers, waylaying for the purpose of committing an assault, assaults on privileged persons, and duels. These were, most of them, common law offences, but were triable in the Star Chamber by virtue of that extraordinary power which the court arrogated to itself in the course of time, and which was confirmed by 3 Henry VII. c. 1. With regard to duellists, though at times they were severely punished, especially if there had been any knavery in the arrangements for carrying out the duel, at other times the punishment imposed on them was no more than that the reprimand of the court should be read by the judge of assize, on his next arrival in the neighbourhood where the duel had taken place.

Fraud included conveyances and gifts in order to defraud creditors. Maintenance was not only the factious support given by great men to their inferiors in order to enable them to maintain their suits at law till the defendant, a person inimical to the lord, was weary to pursue his right or was ruined, but it included the meaner sins of pettifoggers who backed up a doubtful or a dirty case on the understanding that costs should come out of the other side.

Of the law of libel, which was moulded in the Star Chamber, Hudson says, "In all ages libels have been severely punished in this court, but most especially they began to be frequent about the forty-second and forty-third of Elizabeth, when Sir E. Coke was her Attorney-General. In the eye of the court a man was guilty of libel who "scoffed at the person of another in rhyme or prose"; if he personated him "thereby to make him ridiculous"; if he annoyed him by parading his effigy in a contemptuous manner; "or by writing of some base or defamatory letter, and publishing the same to others, or some scurvy love-letter to himself, whereby it is not likely but he should be provoked to break the peace; or to publish disgraceful or false speeches against any eminent

man or public officer." There are cases of convictions for libel where the accused "spoke certain words against the Lord Cardinal"; used uncivil words to the Sheriff of London; and in Elizabeth's time a man was pilloried for saying Lord Dyer was a corrupt judge. Whitelocke, a barrister, was charged before the court for having advised a client that a commission issued by James I. was illegal. John Selden was, in the same reign, summoned on account of a passage in his *History of Tithes*, whereby he had thrown doubt upon the clergy's claim of divine right to them. Some students of Lincoln's Inn were brought before the court for having at a wine party drunk "Confusion to the Archbishop!" (Laud). The informer against them was their own servant, and the Earl of Dorset, who sat at the council board, took advantage of the circumstance to excuse the students by suggesting that the man being constantly in and out of the room, had heard only part of the toast, which, he said, probably was, "Confusion to the Archbishop's enemies!" The students were dismissed with a severe reprimand. Publishers of a libel were as severely punished as the makers; and "to hear it sung or read, and to laugh at it, and to make merriment with it, hath ever been held a publication in law," says Hudson, who would also appear to be the high priest of that immoral doctrine, until recently taught by the English law, that the greater the truth the greater is the libel. For when citing a case in which a "scandalous letter" had been sent, he says with some show of indignation, "and yet the defendant would have undertaken to have proved the contents of the letter to have been true, he thereby charging himself (the plaintiff) with bribery and extortion in his place." Further on he mentions "two gross errors. 1. That it is no libel if the party put his hand unto it. 2. That it is not a libel if it be true; *both which have been long since expelled out of this court.*"

Conspiracy included false accusations and malicious prosecutions. A man named Lee was pilloried, lost his ears, and was branded with F. A. on the face, for accusing some lords of the Gunpowder Plot.

In virtue of its high jurisdiction, "which by the arm of sovereignty punisheth errors creeping into the Commonwealth, ... yea, although no positive law or continued custom of common law giveth warrant to it," the Star Chamber punished disobedience to royal proclamations; attempts to coin, to commit burglary or murder; and to extort money from foolish young men through the medium of infamous women feigning themselves married. It also punished uncivil conduct towards magistrates; arresters of privileged persons, the keepers of dicing-houses, and bowling alleys; enticers of young men into unthrifty marriages; engrossers of wares in order to raise the

price; spreaders of false news; entanglers of young men in money difficulties; invokers of evil spirits. Favouritism by sheriffs, troublesome behaviour on the part of members of guilds, misconduct of privy councillors, abuse of authority by officials—as when Latcher and Skinner whipped Mrs. Nevill in Bridewell—were all punished in the Star Chamber; "in a word, there is no offence punishable by any law, but if the court find it to grow in the Commonwealth, this court may lawfully punish it, except only where life is questioned."

Arrests were made under a privy seal, or on the warrant of the board. Summonses were issued by the same authority. The accused was privately examined, and encouraged to confess and submit himself to the mercy of the court, whereby he often met a lighter sentence than if the law were allowed to run its ordinary course with him. "But in all these cases this is a court rather of mercy than of justice, for if those capital offences should be proceeded against capitally, then must men be tried by course of indictment by their peers *per legem terræ*" (Hudson). If the prisoner confessed, his admission was written down, and shown to him when he was brought to the bar, and then if he recognized it, sentence was passed according to the discretion of the court; if he denied it, witnesses were called to prove it, and Hudson says that in such cases the court in his time often strained the confession unfairly against the prisoner. There was no jury, and the court needed not to be unanimous. The president had a casting vote.

Concerning punishments, Hudson says they are "now of late imposed *secundum qualitatem delicti*, and not fitted to the estate of the person so that they are rather *in terrorem populi* than for the true end for which they were intended." If this was true of Hudson's time, it was much more true of the time of the next and last generation of practitioners in the Star Chamber. The fines imposed by the court in Charles the First's reign were so wildly extravagant that they defeated the object of the imposers, unless, as was the case with the last judgments pronounced by the Star Chamber, the intention was to imprison indefinitely as well as to ruin irretrievably. Imprisonments were ordered in the Fleet, in the Tower, and formerly in the Marshalsea. Loss of ears was the lot of "perjured persons, infamous libellers, scandalors of the state, and such like." Branding in the face and slitting the nose were the punishments of forgers of false deeds, conspirators to take away the life of innocents, false scandal upon the judges, and first personages of the realm." Whipping was used in "great deceits," and in cases where "a clamorous person *in formâ pauperis* prosecuteth another falsely, and is not able to pay him his costs." There was also the punishment of "wearing papers," which,

notwithstanding, Hudson says it "hath been used in all ages," I have not been able to ascertain what it was. It seems to have been at one time the punishment for perjury, "but since Elizabeth, a punishment for oppressors and great deceits." "Sometimes the punishment is by the wisdom of the court invented in some new manner for new offences, as for Traske, who raised Judaism up from death, and forbade the eating of swine's flesh. He was sentenced to be fed with swine's flesh when he was in prison." In a civil cause damages were assessed by the court, the intervention of a jury being a thing unknown there.

The orders and sentences of the Star Chamber were enforced, and contempts were punished by fine and imprisonment; but Hudson says, and we may without any effort believe him, "there was scarce a man found so impudent as would struggle with the sentence of this high court."

Such were the practice and procedure of the Star Chamber administering the judicial powers of the Privy Council. So great an authority, so undefined, and so avowedly beyond the control of either statute or common law, could not fail to be abused, however beneficial the exercise of it might originally have been. As satisfying a want which the known law did not meet, as a corrector of abuses, "creeping into the Commonwealth," as the curber of licentious and violent persons, and as the means of putting in action the king's *patria potestas* for the protection of women, wards, and adolescents, and for other domestic purposes, the Star Chamber was well suited to the men and manners of a half-barbarous era. It was, also, perhaps, justified by the exceptional position in which Elizabeth and her government found themselves, and it is certain that in Elizabeth's reign the authority of the Star Chamber was at its height. But such an institution was altogether unfitted for Englishmen of the time of James I. and Charles I. The ills which it was designed to remedy had, many of them, disappeared, and such as remained the common law courts and the Court of Chancery were quite able to cope with. As a matter of fact, the Star Chamber had of late years relinquished to those courts a vast amount of its business. It applied itself as an instrument of state rather than of law, to the punishment of "mere political offences," and gradually intensified the extravagance of its decrees till it raged with that "savage vigour" which procured its overthrow.

Almost the first business of the House of Commons in the first Session of 1641 was to take into its serious consideration the petitions of Prynne, Burton, Bastwtick, Alexander Leighton, and Lilburne, who had suffered the worst of the Star Chamber's terrors, for offences purely political, and some of

them so trifling, even when judged by the Star Chamber's rules, that had there not been vengeance to satisfy, much more than a desire to prevent inconvenience to the State, the petitioners could not have been sentenced to the dreadful punishments of which they underwent the most ignominious part. The debate, as reported by Rushworth, will well repay the labour of reading it. The result of the debate was the appointment of a committee, upon whom was laid the duty of examining into the merits of the petitions. The petitioners were released from the dungeons into which they had been flung by the *patria potestas;* and Lord Andover, upon the report of the committee, obtained leave to bring in his Bill for the abolition of the Star Chamber. Either intentionally or ignorantly, probably the former, he gave the go-bye to the fact that the Star Chamber had existed before the statute of Henry VII., and taking that statute for his standpoint, as the first which had recognized the court at all, he proceeded to show how the authority conferred by it had been abused. The House of Commons passed the Bill, and sent it to the Upper House. Their lordships desired a conference, and proposed that the Star Chamber, instead of being abolished, should be once more restricted in its operation to the statute of Henry VII. But the Commons were determined to wipe out the blot altogether from the Constitution, and after a slight resistance the Lords passed the Bill.

The 16 Charles I., c. 10, *An Act for the Regulating the Privy Council, and for taking away the Court commonly called the Star Chamber,* recites a number of statutes relating to the council, and the two statutes relating to the Star Chamber, and with special reference to the 3 Henry VII., c. 1, says, "But the said judges have not kept themselves to the points limited by the said statute, but have undertaken to punish where no law doth warrant, and to make decrees for things having no such authority, and to inflict heavier punishments than by any law is warranted"; and because matters taken before the Star Chamber can be taken in the ordinary course of justice, elsewhere and by common law; "and forasmuch as the reasons and motives inducing the erection and continuing of that court do now cease, and the proceedings, censures, and decrees of that court have by an experience been found to be an intolerable burden to the subjects, *and the means to introduce an arbitrary power and Government*"; and also because of the mischievous meddling of the court in civil causes, whereby "great and manifold mischiefs and inconveniences have arisen and happened, and much uncertainty by means of such proceedings hath been conceived concerning men's rights and estates," the Act goes on to abolish in the most sweeping

way the hateful court, and to forbid the restoration of it or the erection of any court like it.

This was a bitter morsel for Charles to swallow. It deprived him of the power to enrich his treasury by fines which could be imposed at the discretion of his own councillors; and it took away that power, yet dearer to arbitrary men, of vindictively pursuing and cruelly punishing those who dared to resist his ordinances. It was tendered for his assent along with the bill for abolishing the High Commission; and when, on the 3rd July, 1641, the king came down to the House of Lords to give his assent to a number of bills, it was supposed these two would have been among them. The discontent which followed upon the discovery that these bills were held over, expressed itself so strongly that it reached the king's ears. Charles came down on the 5th July, and assented to the abolition bills, and referring to the discontent, said, "Methinks it seems strange that anyone should think I could pass two bills of that importance that these were, without taking some fit time to consider of them; for it is no less than to alter, in a great measure, those fundamental laws, ecclesiastical and civil, which many of my predecessors have established."

INDIAN INSECTS—HOUSE VISITANTS.

BY THE REV. R. HUNTER, M.A.

Towards the middle of June, when the Indian hot season is about to terminate, let the eye turn where it will, it sees vegetation languishing and all but dead. For eight months previously there has scarcely been a shower; for two and a half there has blown a wind, hot as the blast of a furnace, which has reduced rivers of respectable magnitude to brooks, and has left streams of inferior size literally dry channels. Trees or plants with leaves of a lively green are scarcely to be met with, except in gardens where appliances exist for artificial irrigation. The animals have crept away into corners, and are at no season of the year less obtrusive. Indeed, one great section of the animal kingdom—the insect class—is almost wanting, the greater number of its varied tribes existing at that season in the chrysalis state.

But by and by, clouds, escaping over the tops, or through the passes of that great rocky rampart which figures in maps as the Western Ghauts, pile themselves around the central Indian sky. After having several times threatened rain, and again withdrawn the menace, till the repeated crying of "wolf,

wolf" has produced the usual effect of making people pay little or no attention to the warning voice, even when it sounds more earnest than usual, they finally begin to discharge themselves on the earth. Sometimes the rainy season (caused by the south-west monsoon) comes on gradually: more commonly, however, a magnificent thunder storm inaugurates its reign. The dry and thirsty land in a few hours becomes green as emerald, and the animals reassert their place in creation. It would scarcely be relevant to the present subject to point out the several elements which go to constitute the wondrous transformation so gladdening to the eye: it is enough to note the phenomena presented by the insect world.

Within a week after the rainy season has established itself, the number of insects which have quitted the state of suspended animation, if one can call it so, and flown forth from their living graves, is very great, nor are their beauties withheld from human observation. The night has just set in, outside the atmosphere is moist, inside it is somewhat close, and Paterfamilias, in sitting down to tea, directs that the doors shall be thrown open. The order is carried out, when a multitude of uninvited guests at once present themselves, attracted, it must in justice be stated, not by his viands, but by the argand lamp which burns so brilliantly upon his table. They are insects of very varied families. On the first two or three occasions when this occurs, the novelty of the spectacle makes one reluctant to interfere with it in any way; but before long scientific ardour receives a check of an unromantic character. As roughs may intermingle with thoroughly respectable processionists, so flying bugs, especially a black species, troop in at the door with the rest of the insect world, and, being somewhat clumsy in their flight, are exceedingly prone to fall full length into the cups of tea. Their smell is precisely that of the domestic pest to which they have so close an affinity; and we fancied, though it may have been no more than fancy, that they imparted both that, and a peculiar taste to the tea into which they tumbled, so that in all cases the cup degraded by the presence of such visitants was sent away. It was therefore found the best policy to keep the doors closed till tea was over, and then fling them open, to afford ingress to the insect crowd waiting outside. When at length leave was granted, the rush began. In they trooped, great and small, representatives of this, and representatives of that order: all directing their way to the common centre of attraction, the lamp upon the table. It was impossible to prevent many from burning their wings or perishing in the flame.

The *Coleoptera* figured in large numbers, many distinct families sending each a contingent to the general muster. One

or two predatory *Cicindelas* were there, though smaller in size, and more sombre in colour than the pretty species of this country. The lamellicorn beetles came; but there was nothing to wonder at in this: it being very common, even when other insects were absent, for a species of this tribe, belonging to the genus *Bulboceros* to wing its droning flight in at the door, and up and down the room, after which it was wont to tumble backwards on the ground, and lie struggling for some time before it could regain its footing, or acquire lever power sufficient to rise upon the wing. Species of genera with soft elytra were, beyond others, numerous in individuals; and this was remarkable about them, as it was indeed more or less of all the other families, that every fortnight or so, the species changed, those that were common at the beginning growing more rare, and those of which there had been seen but a single individual or two becoming numerous.

One of the *Cimicidæ* has been already mentioned. Other *Hemiptera* presented themselves for observation, the one that left the deepest trace upon the memory being a large *Reduvius*, which on being seized, would turn round, and with its suctorial mouth inflict a deep envenomed wound on the finger.

The *Orthoptera* sent to the assembly some species of the locust family, this being noticeable about their habits that, whereas the other insects, while they remained with us, kept with tolerable steadiness to the table, and somehow managed to take themselves off altogether before morning, these, after having had enough of the table, manifested certain proclivities towards the wall, with which they soon made acquaintance and from which they were in no hurry to depart, for they were often to be seen standing there in a sleepy way after sunrise.

A very interesting Neuropterous insect, though not abundant, was still occasionally to be met with—the *Myrmecoleon* or ant lion. It was like a dragon fly, but had much more conspicuous antennæ, and doubtless came from the neighbouring hill, where its larvæ might be disinterred from the bottom of small funnel-shaped holes in the light sandy soil. But of all the *Neuroptera* none figured so conspicuously as the *Termites* or white ants. They were in company with a large black ant of the *Hymenopterous* order, to which they seemed in some way mysteriously drawn. The *Termites* which flew around the lamp had four gauzy wings, but attached to them so lightly that when they dashed against any solid body, their wings flew off, and they became degraded into creeping things, very much like ear-wigs but without the forceps.

The curious insect-drama never looked more anomalous than when it was enacted during the time of divine service in church.

In all probability the lights on either side of the pulpit were brighter than those in other parts of the sacred edifice, and, in consequence, the stream of insect church-goers winged their way thither in quest of enlightenment. Some, loving it "not wisely but to well," soon fell a sacrifice to their ardour; others, directing their course more skilfully, danced in mazy circles around the attractive object, as planets might revolve about a central sun. Some white ants struck the face of the preacher, others deemed his neck the proper target against which to direct their energies, and inpinging upon it, fell as creeping things upon, or occasionally inside his dress; while, if he aimed at reading correctly, it was necessary for him from time to time to brush away the wings from his book.

It were well worth the while of those British entomologists who have correspondents in India to obtain from them *all the species* that frequent these tea-table gatherings, requesting at the same time that accurate note may be taken of the date at which each species first appears, the time when it reaches its maximum in point of numbers, and that again at which it has so far declined that it can scarcely be met with. Such an investigation, if prosecuted simultaneously in various parts of India, and the results compared, the identifications of course not being left to the local observers but undertaken by eminent entomologists at home, could not fail to prove interesting in a high degree.

THE CLIMATE OF GREAT BRITAIN.

BY RICHARD A. PROCTOR, B.A., F.R.A.S.

If there is one feature in the material relations of a country which may be considered as characteristic—as of itself sufficient to define the qualities of the inhabitants, and the position they are fitted to occupy in the world's history—it is climate. "It includes," says Humboldt, "all those modifications of the atmosphere by which our organs are affected—such as temperature, humidity, variations of barometric pressure, its tranquillity or subjection to foreign winds, its purity or admixture with gaseous exhalations, and its ordinary transparency—that clearness of sky so important through its influence, not only on the radiation of heat from the soil, the development of organic tissue and the ripening of fruits, but also *on the outflow of moral sentiments in the different races.*" I do not propose, however, to deal with the constitution of the climate of Great Britain, under this general view. To do so, indeed, would

require somewhat more space than the readers of the INTELLECTUAL OBSERVER would willingly see allotted to a single subject. I wish chiefly to consider the subject of temperature (mean annual and extreme winter or summer); though I may, perhaps, have a few words to say respecting that feature of our climate, which most foreigners consider to be its chief defect—the want of transparency or clearness in our skies as compared with those of some other European countries.

The mean annual temperature of a country is less important to the welfare of the inhabitants than the extreme range of temperature exhibited in the course of the year. Of two countries which have the same mean annual temperature, one may have a climate most admirably adapted to the welfare of its inhabitants, while the other may have a climate offering such fierce and violent extremes of heat and cold that its inhabitants resemble the unfortunates described by Dante, doomed

"—— a soffrir tormenti caldi e geli."

However, I shall deal first with this feature—mean annual temperature—as affording a starting point from which to proceed to other considerations.

If the surface of the earth were perfectly uniform, or symmetrically distributed into districts of land and water arranged in zones along latitude-parallels, and if the strata of the soil were throughout of like density, radiating power, and elevation, the lines of equal mean temperature would be parallels of latitude. This hypothetical condition of things is, we know, very far from representing the true condition of the earth's surface. Land and water are distributed in a manner which hardly presents the semblance of law; elevations and depressions, not merely of areas of limited extent, but of whole countries, are exhibited in each hemisphere; and endless diversities of soil, contour, and distribution, disturb that mathematical uniformity and exactness, which could alone produce the co-ordination of climates under latitude-parallels.

It is to Humboldt that we owe the valuable proposition that maps of the world should exhibit *parallels of heat*, as well as latitude-parallels; and no atlas is now considered complete without maps in which *isotherms*, or lines of equal mean annual temperature, *isochimenals* or lines of equal winter heat, and *isotherals* or lines of equal heat in summer, are exhibited. These lines are usually presented in maps on Mercator's projection, an arrangement which has some advantages, but is not, on the whole, very well suited to exhibit the true conformation of the isothermal lines—the study of which, it has been well remarked, constitutes the basis of all climatology.

In Figs. 1 and 2, the northern hemisphere of the earth is

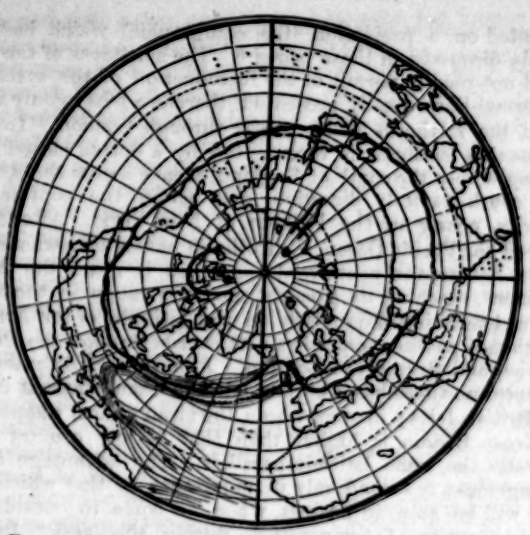


FIG. 1.—Midwinter and Mean-Annual Isotherms of London.

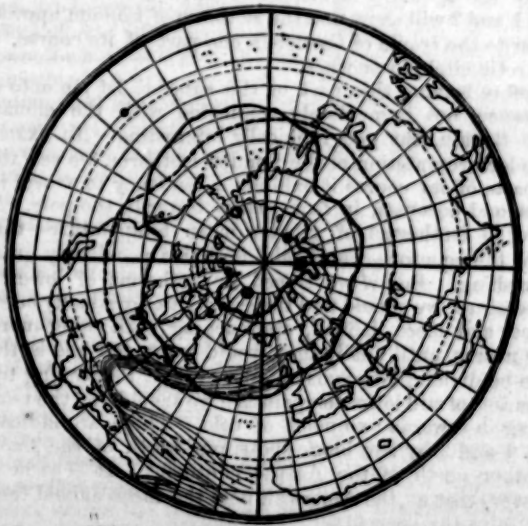


FIG. 2.—Midsummer and Mean-Annual Isotherms of London.

presented on a projection (the equigraphic) which has been already discussed in these pages.* The smallness of the scale would not readily permit of the introduction of the system of isothermal lines usually presented, therefore I have only introduced the isotherm which passes through London. In both figures this isotherm is represented by a dotted closed curve passing across the south of England, thence across the Atlantic in a south-westerly direction, and across the continent of America nearly on the latitude of New York. After it has entered the Pacific Ocean, the isotherm passes somewhat northwards, but trends southwards again as it nears the Asiatic continent, reaching its greatest southerly range in the sea of Japan, traversing Asia nearly on the latitude of the Aral sea, and thence passing somewhat northwards through the Crimea, Vienna, and Brussels to London. Along its whole extent the isotherm nowhere has a higher latitude than where it crosses the British Isles; in other words, the mean annual temperature of Great Britain is higher than that of any country lying between the same latitude-parallels. The advantage of this arrangement is second only in importance to that which England will be seen to possess, when we come to consider the extreme range of temperature during the year. In fact, England is thus brought to the centre of the true temperate zone of the northern hemisphere; since the consideration of Figs. 1 and 2 will show that the isotherm of London approaches as near to the tropic of Cancer in one part of its course, as to the Arctic circle in another.

Before leaving this part of the subject, let me note a circumstance, not immediately connected with the climate of Great Britain, but geographically interesting. In examining the polar presentation of the London isotherm, we see that in two parts of its course it exhibits a tendency to travel northwards, and becomes, in fact, *convex* towards the pole. If we traced in isotherms of greater mean temperature—that is, nearer the equator—we should find this peculiarity gradually diminishing. But if we traced in isotherms of lower mean temperature, we should find the convexities gradually becoming sharper and more defined, approaching each other more and more nearly, until finally they would meet, and the isothermal curve be divided into two irregular ovals. Proceeding to trace out curves of still lower temperature we should find the two ovals closing in towards two poles of cold. These are indicated in Figs. 1 and 2 by two black spots, one north of the American, the other north of the Asiatic continent. It is to be noted, however, that at the American pole the mean annual tempera-

* See the number for July, 1866. The term *isographic* is etymologically preferable to the hybrid word equigraphic.

ture is not quite so low as at the Asiatic pole, the former temperature being 3½°, the latter 1° Fahrenheit.

Returning to our subject, let us consider the all-important question of range of climate. The effects of climate, unimportant to the stronger inhabitants of a country, but largely influencing the health and comfort of the majority, are chiefly felt through the changes that occur during the year. Now, we have seen that the line of mean annual temperature of England departs in a very marked manner from coincidence with a latitude-parallel; but we shall find the lines indicating the extreme temperatures of the year much more irregular; and the peculiarity of climate, which their conformation illustrates, much more important.

In Fig. 1 the *isochimenal*, or the line of equal winter heat, through London, is indicated by a strongly marked closed curve. Its form is remarkable. It passes nearly in a north and south direction, along the length of England and Scotland, approaches suspiciously near to Iceland, but turns sharply southwards and travels across the Atlantic in a direction which brings it to the American continent near Washington; still approaching the tropics, it travels through the northern parts of Texas, where it reaches its greatest southerly range. Passing gradually northwards to the neighbourhood of the Aleutian Islands, it thence trends southwards again, passes through the Corea, traverses the Asiatic continent nearly on the latitude-parallel of Nankin; thence travelling slightly northwards, it crosses the southern part of the Caspian Sea, the Black Sea, the north of Turkey, and passes through Venice and Paris to London. On the continents the isochimenal falls outside (that is, south of) the annual isotherm, while on the oceans the reverse holds. The projection of the isochimenal thus appears as an irregular oval, whose greatest length lies on the continents.

We see here, again, the indication of a tendency to form two curves, and thus of the presence of two poles of extreme winter cold in the northern hemisphere. The isochimenals of greatest cold hitherto traced in the two continents, are shown by two broken curves in Fig. 1. The cold of the Asiatic curve is very much greater than that of the American, the former curve marking a winter cold of —40° Fahrenheit (72° below freezing), the latter a winter cold of —26° 5′, only—if one may apply such an adverb to a cold of 58° 5′ below freezing. Professor Nichol remarks that, "if a polar projection were made of these regions for January, it would be found that the two coldest spaces of these continents form a continuous band passing across the pole of the earth." I cannot but think that this is a mistake. I believe that if the isotherms traced, in

part, in Fig. 1 could be completed, they would be found to form two ovals. The American oval would enclose the American pole of mean temperature, but very eccentrically, showing that the pole of extreme winter temperature lay westwards and southwards, probably near Victoria Land. The Asiatic oval would not probably enclose the Asiatic pole of mean temperature; and the position indicated for the Asiatic pole of extreme winter cold lies on or near the Arctic circle, where it is crossed by the river Lena. At the true pole of the earth the extreme winter cold is probably not nearly so intense as the cold at either of the points here indicated.

From the direction of the isochimenal through London, it is evident that the Eastern Counties and Kent experience the coldest winters of all places in the British Isles, while Cornwall and the south-westerly parts of Ireland enjoy the mildest winter climates. In fact, winter in Cornwall is not more severe than in Constantinople; and in south-west Ireland the winter is still milder, approaching, in this respect, to the winter climate of Teheran.

The contrast, when we turn to the *isotheral* of London, is remarkable. Instead of travelling nearly northwards, this curve passes in a south-westerly direction, reaching its greatest southerly range in the central part of the Atlantic Ocean; thence it travels with a northerly sweep through Nova Scotia and Canada, till it reaches its greatest northerly range near the Rocky Mountains.* Thence it turns sharply southwards, crosses Vancouver's Island, sweeps nearly to latitude 45° in the central part of the Pacific, whence passing slightly northwards it crosses the southern part of Saghalien Island. Here it turns sharply northwards, crosses that very district of Siberia which, in Fig. 1, is occupied by the isochimenal of intensest winter cold, traverses Siberia, and passes near St. Petersburg, through Berlin and Amsterdam to London.

The relations thus presented by the isotheral of London are precisely the reverse of those exhibited by the isochimenal. The isotheral forms a closed, irregular oval, whose greatest length lies on the two oceans. Here it falls outside the line of mean annual heat, while on the continent it falls far within this line.

In another respect the isotheral presents a noteworthy contrast to the isochimenal. While the latter encloses an area largely exceeding the area enclosed by the mean annual line, the isotheral encloses an area noticeably smaller.†

* It is noteworthy that the minimum distance of the isotheral from the North Pole here attained, is exactly equal to the minimum distance of the isochimenal from the equator.

† Here an important advantage of the isographic projection is exhibited. The relation pointed out is altogether obliterated in Mercator's projection, and could only be roughly inferred from any but an isographic projection.

A tendency to break up into two curves is exhibited in the isotheral, even more markedly than in the two other curves. But singularly enough, here, where one would expect more certain information of the existence of poles of cold, since so much more of the northern hemisphere can be traversed in summer than in winter, we have no satisfactory evidence. In fact, the irregular curve marked in near the pole in Fig. 2 is the most northerly isotheral yet determined. The temperature corresponding to this isotheral is 36° Fahrenheit, or four degrees above freezing. From a consideration of the form-variations of the isotherals as they travel northwards, I have been led to the opinion that there exist *three* poles of summer cold, and that these fall not very far from the positions indicated by the small dark circles in Fig. 2.

From the direction of the isotheral line through London, it is evident that along the southern coast of England the heat of summer is greater than in any other part of the British Isles. On the other hand, the northern parts of Scotland, which we have seen, enjoy a winter climate fully as warm as that of London, have a much cooler summer climate. The south-western parts of Ireland exhibit a change even more remarkable. For whereas the winter climate in these parts is the same as that of Persia, the summer climate is the same as that of the very portion of Siberia in which (most probably) the greatest cold ever observable in our northern hemisphere is experienced in winter. The summer of the Orkney Islands, again, is no warmer than that of the southern parts of Iceland.

It appears, then, that the inhabitants of England enjoy three notable advantages as respects climate. First, a higher mean annual temperature than that of any other country so far from the equator; secondly, a moderate degree of cold in winter; and, lastly, a moderate degree of heat in summer. The last two advantages resolve themselves into one, viz., small range of temperature throughout the year. Our range of climate is from about 36° in winter to 62½° in summer, or in all, 26½° Fahrenheit. Compare with this the climate of the country near Lake Winnipeg, with a winter cold of 4° below zero, and a summer heat scarcely inferior to that of London; so that the range of climate is no less than 65°. Yet more remarkable is the variation of climate in parts of Siberia, near Yakutsk; here the range is from —40° in winter to 62° in summer—a variation of 102°, or four times the variation of our London climate. Other parts of the British Isles have, however, a yet smaller range even than that of London. Thus in the south-western parts of Ireland, and in the Orkney Isles, the variation is less than 19°.

Nor is it difficult to assign sufficient reasons for the mild-

ness of the British climate—for our warm winters and cold summers. It will appear, on examination, that nearly all the constant causes affecting the temperature of a climate operate to raise the mean temperature of our year, while, of variable causes those which tend to generate increased heat operate in winter, while those which have a contrary effect operate in summer.

Humboldt enumerates among the causes tending to exalt temperature, the following non-variables:—The vicinity of a west coast in the northern temperate zone; the configuration of a country cut up by numerous deep bays and far-penetrating arms of the sea; the right position of a portion of the dry land, *i.e.*, its relation to an ocean free of ice, extending beyond the polar circle, or to a continent of considerable extent which lies beyond the same meridional lines under the equator, or at least in part within the tropics; the rarity of swamps which continue covered with ice through the spring, or even into summer; the absence of forests on a dry, sandy soil; and the neighbourhood of an ocean-current of a higher temperature than that of the surrounding sea.

All these causes, it will be observed—except the neighbourhood of a tropical continent on the same meridian—tend to increase the mean heat of the climate in England. The great Gulf Stream probably exercises a more important influence than any of the others. Its position is indicated in Figs. 1 and 2. Humboldt attaches a high importance to the presence of a tropical continent on the same meridian; and he considers that the climate of Europe is warmer than that of Asia, because Africa, with its extensive heat-radiating deserts, lies to the south of Europe, while the Indian Ocean lies to the south of Asia. There are objections, however, to the reasoning he adopts. In the first place, if the heat-radiating power of a continent really influenced the country lying to the north, it should tend to lower rather than raise the temperature, for the ascending currents of air would strengthen the currents of colder air pouring in from the north, and these currents—on Humboldt's assumption that the country directly to the north is that affected—would lower the mean annual temperature. It would only be exceptionally that the warmer returning currents would descend, and thus exalt the temperature. It seems clear, however, that Asia is the continent chiefly affected by the heat-radiating power of Africa; since the cold currents from the north travel eastwards, while the warm return-current has a westerly motion. We should thus attribute the milder climate of Europe rather to the influence of the tropical parts of the Atlantic Ocean, than to the cause assigned by Humboldt, and we should invert the effects he

attributes to oceans and continents respectively. With this change—somewhat a bold one, I confess *—we may say that all the non-variable causes tending to exalt temperature operate in England's favour.

The constant causes tending to lower temperature are simply the converse of those above considered.

Of variable causes increasing temperature, the principal are a serene sky in summer, and a cloudy sky in winter. It may appear, at first sight, paradoxical to assign opposite effects to a cloudy sky. It must be remembered, however, that clouds considered with reference to temperature, have two functions: they partially prevent the access of heat to the earth, and they partially prevent the escape of heat from the earth. Now, in summer the first-named influence is more important than the second: the days are longer than the nights; that is, the earth is receiving heat during the greater part of the time in summer. A cause, therefore, which affects the receipt of heat is more important than a cause affecting the escape of heat. On the other hand, in winter, the nights are shorter than the days, and the influence of clouds in preventing the escape of heat becomes more important than their effect on the receipt of heat.† In fact we may compare the influence of clouds to the effects of certain kinds of clothing; flannel, for instance, is as suitable an article of dress for the cricketer as for the skater.

Now the climate of England is remarkably humid both in winter and summer. And this humidity is shown, not so much by the quantity of rain which falls, as by the frequent presence of large quantities of aqueous vapour in the atmosphere. Skies, even, which we in England consider clear, are overcast compared with the deep-blue skies of France or Italy. What the influence of these humid palls may be "on the outflow of moral sentiments" which Humboldt considered to be so favourably influenced by transparent skies, I shall not here pause to inquire. It is clear, however, that the influence of our cloudy skies tends to modify the severity both of our winter and our summer seasons; and these benefits are so great that we may

* Not unsupported, however, by good authority. Thus Professor Nichol, speaking of the climate of Europe, writes: "The air that rises in Africa blows rather over Asia than Europe. The cradle of our winds is not in Sahara but in America." Again, Kaemtz notices, that if the effects of oceans and continents were those assigned by Humboldt, we should find in the western parts of America a colder climate than in the eastern parts; the reverse, however is the case.

† Gilbert White noticed long ago—apparently without understanding—the influence of a clouded sky on the temperature. "We have often observed," he says, "that cold seems to descend from above; for, when a thermometer hangs abroad on a frosty night, the intervention of a cloud shall immediately raise the mercury ten degrees; and a clear sky shall again compel it to descend to its former gauge."

cheerfully accept them as more than a counterpoise for hypothetical injurious effects on "the outflow of our moral sentiments," whatever that may be.

I proceed to consider the actual variations presented in the course of a year in England. As some selection must be made, I shall select the series of observations which have been made at Greenwich during the present century. It will be gathered from the preceding pages that the range of temperature at Greenwich is at least not less than the average range of the British Isles. Greenwich, also, from its neighbourhood to London, and from the number and accuracy of the observations made there, is obviously the best selection that could be made. It must not be forgotten, however, that the climate of Greenwich is not the climate of the British Isles, and that careful observations made in other places have sufficiently indicated the existence of *local* peculiarities, which, therefore, it may fairly be assumed, characterize also the Greenwich indications.

In Fig. 3 the annual variations of mean diurnal temperature are represented graphically. The figure was formed in the following manner:—A rectangle having been drawn, each of the longer sides was divided into 365 parts, and a series of parallel lines joining every tenth of these divisions was pencilled in. The spaces separating these lines represented successive intervals of ten days throughout the year. The shorter sides were divided into thirty-three parts and parallel lines drawn, joining the points of division. Of these longer parallels the lowest was taken to represent a temperature of 32° Fahrenheit (*i.e.*, the freezing point) and the others in order, successive degrees of heat up to 65°. Then, from the Greenwich tables, which have been formed from the observations of forty-three years, the temperature of each day was marked in, at its proper level and at its proper distance from either end of the rectangle. Thus 365 points were marked in, and these being joined by a connected line, presented the curve exhibited in Fig. 3. The lines bounding the months, and the lines indicating 35°, 40°, etc., Fahrenheit, were then inked in and the figure completed.

The resulting curve is remarkable in many respects. In the first place, it was to have been expected that a curve representing the average of so many years of observation would be uniform; that is, would only exhibit variations in its rate of rise and fall, not such a multiplicity of alternations as are observed in Fig. 3. And this irregularity will appear the more remarkable when it is remembered that the temperatures used as the Greenwich means are not the true average temperatures. They were obtained by constructing a curve from the

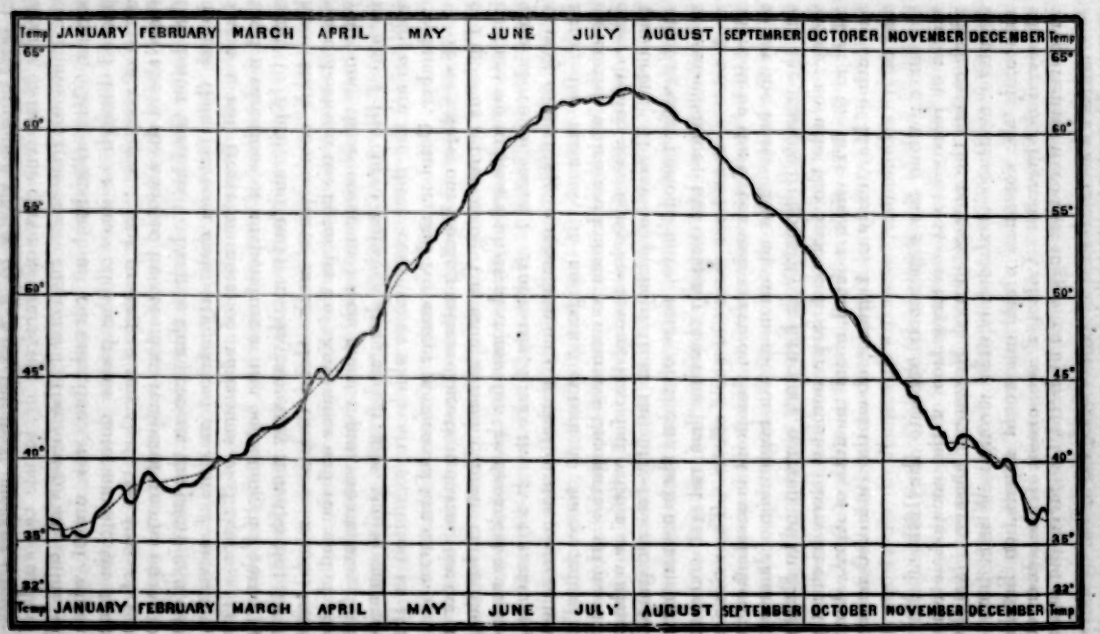


FIG. 3.—Annual Variation of Mean Diurnal Temperature at Greenwich.

true averages, and taking a curved line (the curve of Fig. 3, in fact) in such a way as to take off the most marked irregularities of the true curve of averages; or, to use the words of the meteorologist who constructed the Greenwich table of means, Mr. Glaisher, a curved line was drawn which passed through or near all the points determining the true curve of averages, "and in such a way that the area of the space above the adopted line of mean temperature was equal to that below the line." Despite this process, the curve exhibits no less than fourteen distinctly marked maxima of elevation, and a much larger number of variations of flexure. The sudden variations of temperature at the beginning of February, early in April, and early in May are very remarkable; they have their counterparts in the three variations which take place between the latter part of November and the end of the year, only these occur in much more rapid succession. The nature of the curve between June and August is also remarkable, as are the three convexities which are exhibited in the September, October, and November portions of the curve.

If we follow our leading meteorologists in taking the curve of Fig. 3 as representing the true annual climate of London, how are we to assign physical causes for the remarkable variations above indicated? Not easily, I take it. It were, indeed, as easy as inviting to speculate on cosmical causes;—to follow Ertel, for instance, in assigning effects to those zones of meteorites which are known to intersect the earth's orbit, and others which may fairly be assumed to fall within or without that orbit. It may be, perhaps, that the fifty-two recognized shooting-star periods have, some of them, their counterparts in heat-changes; but certainly the time has not yet come to pronounce a consistent theory of such effects. The evidence afforded by the Greenwich curve on this point is unsatisfactory to say the least. The elevation at the beginning of January, and the marked irregularity in February, correspond to Ertel's views; so also the fact that large aerolites have frequently fallen in the first week in April, about the 20th of April, about the 18th of May, early in August,* about the 19th of October, and early in December, *seems* to correspond to elevations in the curve; while the depression opposite the 12th of May, might be referred to the intervention of the zone of meteors, which causes the now celebrated November shower. But the negative evidence is almost equally strong. Where, for instance, is the elevation which one would expect, on Ertel's theory, in November? Also, if the cause of the observed irregularities were that suggested by Ertel, the curves for other

* Reference is not made here to the August shooting-star shower, which takes place a week later than the epoch alluded to.

countries in the northern hemisphere should exhibit similar irregularities on corresponding dates, which does not appear to be the case. In fact, if there really exist effects due to cosmical causes, these are not likely to be educed from observations of the variation of mean diurnal temperature, since it is clear that a cause of variation due to objects external to the earth could affect only the temperature of certain hours of one day, or of several days. A cluster of meteors between the earth and the sun might diminish the mid-day heat; one external to the earth's orbit might increase the nocturnal temperature; and though in either case the mean diurnal temperature would be affected, yet it is obvious that the effect would be masked in taking the mean, or even that two or more opposing influences might cancel each other. If it could be shown that the curve for mid-day, or for midnight heat corresponded to the curve of mean heat, Ertel's theory would be overthrown at once; since, for its support it is necessary to show that depressions in the mean curve are due to mid-day loss of heat, and elevations to midnight gain of heat.

There are, however, terrestrial causes to which the irregularities of our curve (which irregularities, be it remembered, represent *regularly recurring irregularities* of heat) may be ascribed. For instance, there can be no doubt that our climate is considerably affected by the changes which take place in the Polar seas; and it may not unfairly be assumed that the processes by which different regions of Polar ice are successively set adrift (to be carried southward by the strong undercurrent known to exist in the northern Atlantic Ocean), take place at epochs which recur with tolerable regularity. And it may be that the irregularity of the rising, as compared with the falling half of the heat-curve is due to this cause; since the breaking-up of ice-fields, and their rapid transport southwards would clearly produce sudden changes, having no counterpart in the effects due to the gradual process of freezing.*

It may well be, however, that the observations of forty-three years are not sufficient to afford the true mean diurnal temperature for a climate so variable as ours. Indeed, if the curves given by Kaemtz for continental climates be as accurately indicative of observed changes, as that of Fig. 3, we must either accept such an hypothesis, or else assume that the English climate is marked by regularly recurring variations altogether wanting in continental climates; and it is to be noted that the regular recurrence of changes is a peculiarity wholly distinct from variability of climate, properly so termed, and seems, even, inconsistent with such a characteristic. It

* Icebergs have been seen travelling southwards against a strong northward surface-current, and even forcing their way through field-ice in so travelling.

may happen, therefore, that the observations of the next thirty or forty years will afford a curve of different figure; and that by comparing the observations of the eighty or ninety years, which would then be available, many, or all of the irregularities exhibited in Fig. 3 might be removed. In this case we might expect our climate-curve to assume the form indicated by the light line taken through the irregularities of Fig. 3. It will be observed that this modified curve exhibits but one maximum and one minimum. It is not wholly free, however, from variations of flexure. It presents, indeed, six well-marked convexities, and as many concavities; in other words, no less than twelve points of inflexion. The most remarkable irregularity of this sort, is that exhibited near the end of November; and it is noteworthy that this irregularity is presented by continental climate-curves also. It has been ascribed by Ertel to the effect of the meteor-zone, which causes the November shower. But as it is exhibited by the curves of *horary* as well as of *diurnal* means, while the meteor-zone cannot by any possibility affect the temperature of the earth's *following hemisphere*, and as, further, it does not correspond to the true date of the shower, this view may be looked upon as doubtful. The August curve occurring near the maximum elevation—where slow change was to be expected, is also well worthy of notice; as are the January and May flexures.

It will be noticed that nothing has been said of extreme heat or cold occasionally experienced in England. As such visits generally last but for a short time, their effects are not very injurious, save on the very weak, the aged, or the invalid. Corresponding to the passage of an intense heat-wave or cold-wave, there invariably occurs a sudden rise in the mortality-returns; but almost as invariably the rise is followed by a nearly equivalent, but less sudden, fall; showing, conclusively, that many of the deaths which marked the epoch of severest weather occurred a few weeks only before their natural time.

The weather during a part of the late winter was somewhat severer than our average English winter-weather. The thermometer, however, at no time descended below zero, as it did on January 3, 1854; and the diurnal mean did not descend at any time so low as 10° 7′, as it did on January 20, 1838. There is no foundation for the opinion, sometimes expressed, that our winter-weather is changing. An examination of the columns in the Greenwich meteorological tables, show that the successive recurrence of several mild winters is not peculiar to the last decade or two. The observations of Gilbert White, imperfect as they are compared with modern observations, point the same way.

Among severe, but short intervals of cold weather, may be

noted that which occurred in January, 1768. The frost was so intense, says Gilbert White, "that horses fell sick with an epidemic distemper which injured the winds of many and killed some; meat was so hard frozen that it could not be spitted, nor secured but in cellars; and bays, laurustines, and laurels were killed."

White's account of the summer of 1783 will fitly close our sketch of British weather-changes. "This summer," he says, "was an amazing and portentous one, and full of horrible phenomena; for, besides the alarming meteors and tremendous thunder-storms that affrighted and distressed the different counties of this kingdom, the peculiar haze, or smoky fog, that prevailed for many weeks in this island, and in every part of Europe, and even beyond its limits, was a most extraordinary appearance, unlike anything known within the memory of man. By my journal, I find that I had noticed this strange occurrence from June 23rd to July 20th, inclusive, during which period the wind varied to every quarter, without making any alteration in the air. The sun at noon looked as blank and ferruginous as a clouded moon, and shed a rust-coloured ferruginous light on the ground and floors of rooms, but was particularly lurid and blood-coloured at rising and setting. All the time the heat was so intense that butchers' meat could hardly be eaten the day after it was killed; and the flies swarmed so in the lanes and hedges, that they rendered the horses half frantic, and riding irksome. The country people began to look with a superstitious awe at the red, lowring aspect of the sun. Milton's noble simile, in his first book of 'Paradise Lost,' frequently occurred to my mind; and it is, indeed, particularly applicable, because towards the end, it alludes to a superstitious kind of dread, with which the minds of men are always impressed by such strange and unusual phenomena:—

> 'As when the sun new risen,
> Looks through the horizontal, misty air,
> Shorn of his beams; or, from behind the moon,
> In dim eclipse, disastrous twilight sheds
> On half the nations, and with fear of change
> Perplexes monarchs.'"

THE VEGETABLE SHEEP OF NEW ZEALAND.

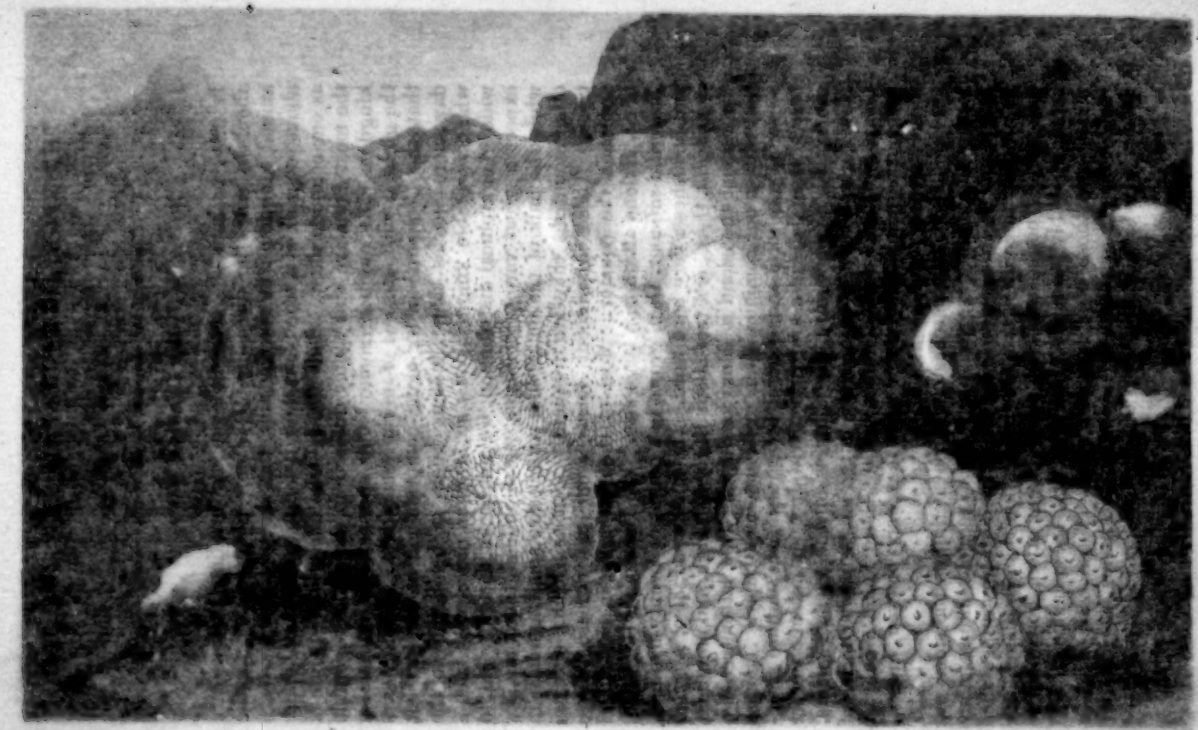
BY JOHN R. JACKSON.

Curator of the Museum, Royal Gardens, Kew.

(With a Coloured Plate.)

It may, perhaps, be thought from our heading that we are about to note the discovery of a new phenomenon in the animal kingdom; on the contrary, the sheep of which we are about to speak is a true plant, and belongs to the same family as our common daisy. This family—the *Compositæ*—is one of the most extensive and widely diffused in the whole vegetable kingdom. It numbers some 1,000 species, and no part of the globe is without some of its representatives. Lindley says that the *Composite* order alone comprehends at the present day more species than Linnæus knew as belonging to the whole vegetable kingdom. In so large an order, with such a wide geographical distribution, we might be naturally led to expect a great variety of forms, which indeed there are, for while the bulk of the *Composites* with us are small annuals, in other countries they are frequently seen as shrubs, or even trees. These arborescent forms seem to increase as we approach the equator. Most of the *Compositæ* in the island of St. Helena attain to a large size. The Tasmanian Dogwood, *Bedfordia salicina*, Dec., grows to a height of twenty-five feet, and furnishes a very hard word. The muskwood, also, *Eurybia argophylla*, Cass., is a tree about thirty feet high, and abundant throughout the island in damp localities. This latter tree is a near ally to our common aster, or Michaelmas Daisy. Though so variable in form and general appearance, the minute structure of the *Composites* are particularly alike, so that an observer cannot fail to recognize the affinities of the various plants. New Zealand is the head-quarters of the most singular forms of *Compositæ*; such forms, indeed, as are there found would at first puzzle many to determine what they were, or even, indeed, if they were a vegetable at all.

Peculiar-looking patches are to be seen upon the sides and tops of the mountains, which in the distance look like so many sheep, and even upon nearing them their shaggy appearance help rather to confirm the first impression than to dispel such a notion. Upon a somewhat closer examination, however, we should possibly be ready to believe that these hemispherical masses are those of a gigantic moss. These tufts are, in reality, masses of plants belonging to the genus *Raoulia*, one species of which is known to the New Zealand settlers as the



"vegetable sheep." The shepherds themselves are often deceived by them when calling in their sheep from the mountains. Our plate will give an idea of the general appearance of the plant, to the right of which is represented another singular plant, *Haastia pulvinaris*, of which we shall also give a brief description. *Raoulia* is very nearly allied to *Gnaphalium* and *Helichrysum*, to which latter genus the everlasting flower, or *immortelle* of the French, belongs. The principal difference exists in the narrow receptacle of the flower-heads of *Raoulia* compared with that of the other two genera. The singular habit and general appearance of the plant are also prominent distinguishing characters. Dr. Hooker says it is "a genus founded on habit more than on any good characters that can separate it from *Gnaphalium*, section *Helichrysum*. Its herbaceous habit distinguishes it from *Ozothamnus*. It contains two natural and most distinct sections, of which one, containing *R. subulata, eximia, grandiflora, mammilaris*, and *bryoides* has a convex, often hispid, receptacle; achenes with very long, silky hairs, a thickened areole at their base, and stout, rigid, opaque, pappus hairs, thickened at the tip. These probably constitute a good genus, to which the name *Raoulia* may be retained; the others may, perhaps, fall into *Gnaphalium* or *Helichrysum;* but until all the *Gnaphalioid Compositæ* are worked up, it is impossible to settle the limits of the genera."

Though there is a difference in the habits of the two genera, *Gnaphalium* and *Raoulia*, the woolly appearance occurs in both, for the leaves, stems, and flowers of many species of the former genus are completely covered with a greyish, soft, velvety down. Twelve species of *Raoulia* have been discovered in New Zealand, where the plants are alone found. These species have all been named and described by Dr. Hooker, as well as the genus itself, which is in honour of M. Raoul, a surgeon in the French navy, who has paid some attention to New Zealand plants. It may be interesting to our readers if we give a description of each of the species, abridged from the *Handbook of the New Zealand Flora*.

1. *Raoulia Australis*, Hf. A small, moss-like, densely-tufted plant, stems one to two inches high, branches slender, leaves minute, laxly or densely imbricate, half an inch long, covered with silky, appressed wool. Heads one-eighth of an inch long, outermost scales spathulate, inner linear, shining yellow or pale brown, not dark at tips, nor white and radiating; florets about twelve, outer few, pappus hairs excessively slender, subpilose, not thickened at the tips. Achene glabrous. This species is found on lofty, rocky hills in the Northern Island, on the Nelson Mountains, Otago, and other places in the Middle Island.

2. *R. tenuicaulis*, Hf. Stems generally slender, loosely tufted, prostrate, creeping, one to ten inches long, with ascending branches. Leaves loosely imbricating, spreading and recurved, one-twelfth of an inch long, grey, with appressed silvery tomentum. Heads very similar to those of *R. Australis*, but involucral scales, with brown acute tips. Found in the gravelly beds of rivers in Northern Island, and also at Kowai River, Middle Island, at an altitude of one to two thousand feet.

3. *R. Haastii*, Hf. A small, densely tufted, nearly glabrous plant, stems rather stout, prostrate, branches one inch high. Leaves densely imbricate, one-sixteenth of an inch long, broadly sheathing, broadly ovate, coriaceous, obscurely woolly or silky. Flower-heads similar to those of *R. Australis*, but narrower, with six to eight florets; involucral scales obtuse, not brown, nor with a white radiating tip. Found in gravelly terraces at Kowai River and Waiauna Valley.

4. *R. Munroi*, Hf. Stems slender, creeping, with very long, wiry, filiform rootlets. Branches slender, ascending, one to two inches high. Leaves laxly imbricate, one-eighth to one-sixth of an inch long, linear, obtuse, uniformly clothed with grey, silky tomentum. Heads narrow, one-sixth of an inch long; involucral scales glabrous, linear, green, with rather dilated, scarious brown tips; florets about twelve; pappus as in *R. Australis*. The wiry stems and very long filiform rootlets are prominent characters, as are the uniformly grey, silky, linear leaves, and narrow heads, with brown-tipped, involucral scales. The plant has been found in Waihopai Valley and Canterbury Plains.

5. *R. subulata*, Hf. A small, very densely tufted, rigid, moss-like species, quite glabrous throughout, blackish when dry, stems stoutish, branches half an inch high. Leaves most densely imbricate, patent or suberect, rigid, subulate, acuminate. Heads large for the size of the plant, one-sixth of an inch in diameter; involucral scales linear, oblong, scarious, shorter than the leaves; receptacle convex, hispid: florets of circumference in several rows, pappus of rigid, scabrid hairs, rather thickened at the tips. Achene silky. A remarkable and very small species, differing much from the foregoing in the pappus, hispid receptacle, and foliage. This species is found on the Nelson and Otago Mountains, at an altitude of from five to six thousand feet.

6. *R. eximia*, Hf. The vegetable sheep. A small, most densely-tufted, hard little plant, forming large woolly balls on the mountains, enveloped in soft, velvety, white tomentum; branches very short, with the leaves forming cylindric or mammilliform knobs, one quarter of an inch in diameter;

leaves most densely compacted, wholly hidden amongst woolly hairs, imbricated all round in many series, one-eighth of an inch long, membranous, broadly linear or obovate oblong, rounded at the tip, bearing at the back, above the middle, a dense thick pencil of white velvety hairs, these bundles of hairs, meeting beyond the leaves, envelope the whole. Heads minute, sunk amongst the upper leaves, involucral scales about ten, linear, with subulate or obtuse tips, and a tuft of hairs on the back above the middle: receptacle convex, naked; florets about ten. Pappus of few rigid hairs, thickened upwards. Achene with a thickened areole at the base, silky, with very long hairs; very nearly allied to *R. mammilaris*. Found in the Middle Island, at Ribband Wood Range, Mount Arrowsmith, and Dobson, at an elevation of 5500 to 6000 feet.

7. *R. Hectori*, Hf. Most densely tufted, one to two inches high; branchlets erect, densely leafy, silvery at the tips. Leaves closely imbricate one-twelfth of an inch long, broadly ovate, obtuse, coriaceous, upper half covered with appressed silvery, shining tomentum; back grooved longitudinally when dry. Heads small, sunk amongst the uppermost leaves; involucral scales scarious, linear-oblong, obtuse, yellowish, glabrous, receptacle convex, pilose; florets about twenty. Pappus of few, rigid, scabrous hairs, thickened upwards. A very distinct species, resembling in habit some states of *R. Australis*. Found in the lake district of Otago in dry, subalpine places.

8. *R. glabra*, Hf. Stems elongate, slender, prostrate, branching, two to ten inches long; branches ascending. Leaves laxly imbricate, spreading, hardly ever recurved, one-sixth of an inch long, linear, or linear-oblong, acute or obtuse, glabrous or nearly so, one nerved, green. Heads rather large, one-fourth to one-third of an inch in diameter; outer involucral scales leaf-like, inner linear, with short, white, radiating tips; florets numerous, outer in two series. Pappus of numerous soft, white, slender hairs, as in *R. Australis*. Achene covered with down. Found in the Nelson Mountains, Mount Cook, and Otago Mountains.

9. *R. subsericea*, Hf. Very similar in most respects to *R. glabra*, and perhaps an alpine variety of that, but a much more densely-tufted plant, with very short stems and branches; closely imbricated, linear-oblong leaves; glabrous or covered loosely with silvery tomentum; green or silvery white. Heads similar, but larger. Found in many parts of Middle Island, up to an elevation of from 3000 to 4000 feet.

10. *R. grandiflora*, Hf. A very short, erect, densely-tufted species, with very long, wiry, thread-like roots; stems one inch high, densely leafy, with the leaves on as thick as the little finger. Leaves imbricating all round the stem one-sixth

to one-fourth of an inch long, rigid, shining, with white, silky hairs, cottony; at the base, striate. Heads large, one-third to two-thirds of an inch in diameter; involucral scales one to two series, long, white, linear, spreading, one-fourth of an inch long; receptacle convex, hispid. Pappus hairs few, rigid, swollen towards the tip. Achene silky. Found in the Northern and Middle Islands, at the top of Gordon's Nob, Mounts Cook, Darwin, and Torlesse, at an elevation of from 5000 to 7000 feet, as well as on other mountains, widely spreading, and forming perfect carpets.

11. *R. mammilaris*, Hf. Like *R. eximia* forming large, hard, hemispherical balls and patches on the ground, sometimes eight feet long and three feet high; branches very short, thick, with the leaves on, forming cylindric or mammilary knobs one-fourth of an inch in diameter. Leaves most densely compacted, imbricated in many series, spreading, one-tenth to one-twelfth of an inch long, obovate cuneate, or spathulate, cottony below, with a dense brush of velvety hairs on both surfaces beyond the middle, which does not exceed the tip of the leaf. Heads very small, one-sixth of an inch in diameter, about ten flowered; inner involucral scales with short, white, acute, radiating tips; receptacle, convex, naked. Pappus of few rigid hairs, thickened at the tips. Very similar in many respects to *R. eximia*, and closely allied to it; but the leaves are smaller, with the velvety hairs not so long as to hide them, more cottony and obovate, and the inner involucral scales are distinctly rayed. Achene with a swollen areole at base, and long, white, silky hairs. Found on hard soil and rocky places on Mount Torlesse, at an altitude of 3000 to 5000 feet.

12. *R. bryoides*, Hf. Forms hard, dense, convex, hoary patches, with an even surface; branches one-half to one and a half inches long, densely compacted, with the leaves on cylindric. Leaves most densely imbricate all round the branches; erecto-patent one-twelfth to one-tenth of an inch long, broad, linear, rather dilated at the obtuse tip, membranous, coriaceous; margins cottony, glabrous below the upper one-third, above that covered with appressed silky wool, one nerved. Heads one-fourth of an inch in diameter, about twelve flowered; involucral scales with white, subacute, radiating tips; pappus hairs few, rigid, with thickened tips. Achene with very long white hairs, and a thickened areole at the base. Found at top of Gordon's Nob, in the Clarence and Wairau Valleys, at an elevation of 3000 to 4000 feet.

From the foregoing descriptions it will be seen that though the whole of the species agree in many points of detail, the general appearance of some are widely different from that of

others. *R. eximia* is certainly the most peculiar, forming large masses like cushions, often two feet high and three feet in diameter, and this species is known to the natives as the vegetable sheep. A fine tuft of this plant is in the Museum, Kew. The plants indeed, on the whole, have more the appearance of mosses than exogens, the tomentum of the leaves of many of the species being developed to such an extent as to completely envelope them, and almost to conceal the star-like flower-heads, which are seated at the apex of each short twig.

R. grandiflora, as its name indicates, is a very beautiful little plant when in flower; the involucral scales, which are white, might readily be mistaken for the ray florets; but these, like the disk florets, are tubular. The pappus hairs, seen under a microscope, are rough, the edges being apparently clothed with small prolongations, but the thickness and rigidity of these vary much in the different species.

Nearly allied to *Raoulia* is the genus *Haastia*, named by Dr. Hooker in honour of Dr. Julius Haast. The plants have a very similar habit to *Raoulia*, forming balls or cushions on the lofty mountains. These species are mentioned as growing in New Zealand, but *Haastia pulvinaris*, Hf., is the most remarkable; indeed, Dr. Hooker says that it is one of the most remarkable plants in the islands. Masses occur quite three feet in diameter, covered with fulvous wool. The leaves are crowded, broad, but completely hidden in the wool. This is a very close-growing plant; indeed, the patches of it are too dense even to admit of the finger being thrust between the branches. It has been found on mountains at an elevation of 5800 feet. The tufts represented in the plate are those of young plants.

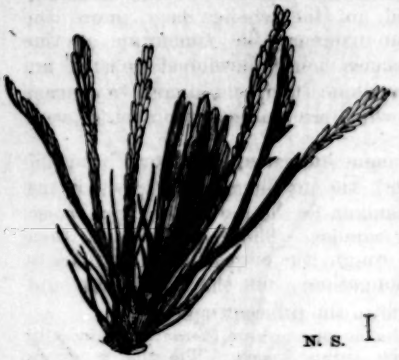
Though singular and interesting to the botanist, these plants are of no value economically, but, on the contrary, as we have shown, certain species of them are a plague to the shepherds, inasmuch as they give them much trouble and annoyance to discern between an animal sheep and a vegetable sheep.

Leaves and Flowers of the Vegetable Sheep.

BY HENRY J. SLACK, F.G.S., HON. SEC. R.M.S.

Through the kindness of Mr. Jackson, I have been able to examine the leaves and flowers of the "vegetable sheep" (*Raoulia eximia*) as they exist in the Kew specimen. When I saw that specimen in the summer of last year, I was struck by an appear-

ance of several bodies projecting from the general surface like minute outgrowths. On microscopic examination they appeared to consist of flowers in a dry state, surmounting immature achenes (or *seeds*), at the base of which were fleshy rings, apparently in a living state. The appearance of these flowers is shown in the annexed woodcut, which is reduced from a drawing made on a larger scale. It will be seen that there are two kinds of hairs, one simple and the other highly complex. The former spring from the annular disc or fleshy ring at the base of the achene, and from the body of the achene, while the latter arise from the flower which is above it. The dark mark shows the point at which the flower and achene divide. The composite hairs consist of a number of small tubes delicately white, and with slightly wrinkled surfaces. They require powers of from 100 and upwards for their effective display. The number of the tubes in these compound hairs varies considerably in different specimens. In one I counted sixteen tubes in the central part. The tubes at the sides throw out projections with pointed tips, and another tube usually joins the diverging tube, and continues a straight course. On one of the flowers, which was slightly broken so as to show its interior, I noticed small pale-yellow pollen grains, which show no inclination to shrivel up.



COROLLA AND ACHENE.

The most curious fact is, that the annular discs or fleshy rings at the base of the achenes contain pale, yellow-green chlorophyll, apparently in a living state, although the Kew specimen plant looks quite dry, and has been a year or two in a glass-case in a warm room. My specimens, which have been mounted under their glass covers for many months, still look plump and fresh, and it would appear that the plant is so constructed as to bear a prolonged drought without losing its vitality by excess of evaporation—at least, that is the conclusion to which I have been led by examining these flowers, and some sections which I made of the stem.

The leaves are very curious microscopic objects. In the dry state they, like the flower, are brown. They consist of

elongated cells, surrounded in some cases by smaller rows of bead-like cells. The hairs are of a glittering pearly whiteness, very numerous, of wavy outline, like the tentacles of an anemone, and pointed at the end. They are not like the hairs of the corolla, complex, but of a simple tubular structure, without joints. The woodcut will convey an idea of the appearance which these hairy leaves exhibit under the microscope, and it will be readily understood, that as the leaves are closely compacted round the short stems, and as each leaf is furnished with a projecting mass of hair, the whole plant possesses the woolly appearance which Mr. Jackson describes, and from which, together with its shape, the appropriate name of "vegetable sheep" is derived.

LEAF.

I should be much obliged if any one who reads these pages in New Zealand would send to me, addressed to care of Messrs. Groombridge, some ripe achenes or seeds of this curious plant, and some flowers in a perfect state.

PLEASANT WAYS IN SCIENCE.

No. V.—Radiant Forces.

If a candle is placed in the centre of a room, it diffuses light equally in all directions, and consequently all parts are lit in regular proportion; upwards, downwards, on this side, and on that go the light rays, and if an obstacle meets them, they pass on either side of it, leaving a shadow behind it. The candle flame gives light because it is full of incandescent particles, each of which behaves in the manner mentioned; and we may figure the minutest conceivable particle bristling all round with light rays, which we might roughly imitate by sticking pins as close together as possible all round a tiny cork ball. We might approximate a little nearer to the truth, but yet be almost infinitely far from the wonderful minuteness of nature, by drawing with the finest pencil an immense number of the most delicate lines as close together as possible, and all radiating from one point, which would represent an incandescent particle distributing its light rays *in one plane* only, whereas the real particle distributes them in *all* planes.*

It is easy to draw two lines on a sheet of paper, diverging from the same point so gradually and so close together at the commencement, that at a distance of two or three feet they should be a very little way apart. Suppose, however, we were required to draw two such lines, which, commencing a slight divergence in London, should be found only an inch apart at York, how impossible would be the task. Still more impossible would it be for us to draw two lines for a few feet or a few inches which should have only such a rate of divergence that they would nearly touch each other if prolonged round the globe to New Zealand, or were extended some 240,000 miles off, until they reached the surface of the moon. The sun is about 92,000,000 of miles from the earth, and yet, according to the explanations usually given, each incandescent particle of his photosphere sends forth rays so tightly packed together, that many pairs of them reach our earth without the distance between them having become perceptible, notwithstanding they have been getting further apart from each other every yard they have advanced in their enormous journey! Still more astounding is it to conceive that the sun sends to the remote planet Neptune, which is more than thirty times as far from that luminary as our earth is, sets of diverging rays so closely packed, that many pairs of them

* An orange may be cut through its centre into slices, each slice representing one of the innumerable planes into which it may be conceived capable of division.

arrive at his distant surface, which deviated infinitesimally from true parallelism at the time of starting.

By drawing two diverging lines on a piece of paper, it is easy to see that at certain distances they can only reach bodies of proportionate dimensions. Thus, if at six inches from their point of starting, two diverging lines exactly touch the top and bottom of a perpendicular line one inch long, it will be found at six inches further, or one foot from their starting point, they will exactly touch the top and bottom of a line two inches long.

If it be desired to make these matters plain to young people, it will be better to construct a model than to draw a diagram. This may be easily done by fastening a pin to a piece of wood or cork, and carrying from it two lines of thread, to the top and bottom of a perpendicular line running through the centre of a piece of card two inches square, and one foot removed from the pin. A second piece of card, one inch square, should be placed six inches nearer, and the threads will exactly pass over the upper and lower surfaces of the two cards. Two other threads should then be extended so as to touch the cards at positions exactly at right angles to the former. It then becomes evident to the eye that a card one inch square, at six inches from the pin, which represents the source of light, can receive as many diverging rays as can be caught by a two-inch square at double the distance. But a two-inch square has a surface equal to *four* one-inch squares (as may be readily demonstrated by experiment*), and therefore, a portion of the two-inch square, equal to a one-inch square, could only receive one quarter as much light as the one-inch square could receive, through being at only half the distance of the former one from the source of light.

This model, or a diagram, will show, that for diverging rays to reach an object of moderate dimensions, like the two-inch card, a little way off the source from which they radiate, it is necessary that they should diverge at a very gentle rate. Rays that diverge rapidly can only be caught by a moderate sized object when it is placed near to the point from which they proceed, and even so large an object as our earth can only receive from the sun rays that for all practical purposes must be regarded as parallel, though a large number of them reach us with an infinitesimal divergence.

Astronomers calculate the quantity of light and heat that can be received from the sun by the different planets revolving round him, by estimating their distances from the central orb.

* In teaching young folks, or uninstructed adults, these things should be shown by cutting pieces of card, and placing four one-inch squares on one two-inch square.

If we receive a quantity which we may term x, a planet twice as far off would receive only one quarter of x quantity; and one three times as far off one ninth, and so forth, till we come to such remote planets as Uranus and Neptune, when the fraction becomes minute.

If we adopt the explanation of *diverging rays*, the sun may be regarded as an infinite number of incandescent points, from each of which proceeds one ray, which we call a direct ray, as it proceeds straight forward towards our earth. Of such rays, only those could reach us which emanated from a surface not larger than our own, or so little larger, that the effect of the refractive action of the ether of space, if such there be, and of the refractive action of our atmosphere, could still bend them so as to reach us. Each particle of the solar photosphere would be supposed to emit one of these direct rays, and an infinite number of rays slanting more or less away from it on each side. Now, however slight may be the divergence of any two rays, there must be a distance beyond which they could not both touch any object of given dimensions. Let us suppose, for example, the case of two rays which diverge at the rate of an inch in a million of miles. They could not both fall upon an object rather more than a million of miles away from their starting-point, and not more than an inch in diameter. At exactly one million of miles' distance they would both meet the edges of such an object, but beyond that distance they would pass by it, and at two millions of miles they could not both at once be nearer than within half an inch of it, though one might touch it, and the other be still further off, if it were appropriately placed for such a result.

The proportion of diverging rays which planets could obtain from the sun would follow the rule of inverse proportion that has been explained, but not so the rays that come from him in parallel lines. If they were not obstructed by any medium diffused through space, they would go on for ever without diminution; and if there were two bodies smaller than the sun, and at gigantic distances from it, the nearest being so far off that it could not receive any diverging rays emitted by the sun, and the remotest three times, or ten times, that distance, they would both be equally well illuminated, and would receive equal quantities of light on equal areas of their surface.

As light may be considered, with approximate certainty, to consist of vibrations of a highly attenuated fluid, which has not yet been discovered to possess any weight or sensitiveness to the action of the attraction of gravitation, we must suppose such a fluid diffused through space, and capable of transmitting the light waves. This fluid has been thought to oppose a certain obstacle to the passage of light waves, so that it could not pass

along an immense space without a loss of power; and a sufficient length of space might at last bring it to a state of rest, which would be equivalent to destroying its character as light. Indeed, that character would cease long before rest was attained, because no eye, constructed upon the principles of human eyes, could be impressed with the sensation of light, unless the velocity of the ether vibrations were sufficiently great. As soon as they declined below a certain quickness, they would cease to excite the sensation of light, and vision can take no cognizance of them.

If light were regarded according to the Newtonian theory of its consisting in an emission of particles, mathematicians would have to calculate how closely it would be possible for independent light-streams to be packed together; and when assigning to any two of them an infinitely small divergence, to compute how far they must travel before the divergence would increase to such an extent, that they must pass on either side of an object like our earth or one of the planets. It would be interesting to know, according to this theory, what proportion the truly parallel rays from the sun would bear to the diverging rays which strike upon the various members of his system.

The emission theory is, however, generally abandoned, and the term "ray" needs special explanation when used in connection with the undulatory theory of light. If we throw a stone in the centre of a still pond, we notice a series of concentric hollows and ridges, spreading out wider and wider, and growing fainter and fainter, until, if the pond be large enough, they gradually vanish in the smooth surface. If the pond is small in proportion to the size of the stone and the force with which it strikes the water, strong waves continue up to its banks, and are reflected back again, producing noticeable interferences with advancing waves. Now in these actions, or in the first of them, the spreading of waves from the centre to the circumference of the pond, we do not notice any analogy to "rays;" but if we consider that every hollow and ridge consists of multitudes of water particles in a state of oscillation, the term "ray" might be applied to each diverging series of particles, arranged in sets, one in front of the other, which oscillate or move up and down in the same vertical plane, and which all owe their motion to a transmission of force from one of the originally moving particles. From the cohesion of the water particles there are no lateral gaps between these water "rays." Each particle of water imparts its own motion to its neighbours, and as the waves increase in size, the number of particles in motion becomes greater. The effect of this constant addition of particles to the wave system is, that the

original quantity of motion has to be divided amongst a greater number of particles, and consequently each one will have less. Thus the further the waves are away from the stone, the less will be their height and depth; or the smaller they will become when measured *vertically*, although they are greater in breadth.

This water comparison does not, however, afford a complete idea of the propagation of light, because we notice only what takes place at the surface of the water. If a diver exploded a circular mass of gunpowder at a given depth, the water would be struck equally in all directions, and the wave produced would be like a series of spherical shells, one outside the other. Each shell would contain more water particles than the one next to itself and *nearer* the source of motion, and fewer particles than the one next to it and *further* from that source. Thus in the spherical waves nearest the explosion the motion of particles would be violent, and it would grow less and less violent as the spherical waves grew wider and wider, as they receded from the centre of explosion.

A particle of matter becoming luminous acts like the explosion supposed in the case of the water. It communicates a strong wave motion to a spherical shell of the adjacent ether, and the particles of that first shell hand it on to a second, and so on in infinite progression. As long as the waves have force enough to be visible we call them light. If the ether particles have sufficient attraction for each other, the process must go on, as in the case of the water; but is this known to be fact? Is it certain that the spherical shells of light are continuous and without break in the sense in which spherical water waves possess that property?

If we consider light as propagated in waves like concentrated spherical shells, a light ray will consist of the oscillations of all those particles which stand in front of the first moved particle, which acts as their source of motion, by communicating to them its own motion.

Optical experiments show that one set of light rays may be made to pass through another set without apparent loss. The method of illuminating opaque objects under high powers, originating with Professor Smith, of Kenyon College, as described in a former number of the Intellectual Observer, and well-known in this country through the contrivances of Mr. Richard Beck, and Messrs. Powell and Lealand, illustrate this fact. Light rays are sent down through the object-glass on to the object, and then, being reflected by the object, they come back again without jostling one another, so far as can be discerned. But, by another kind of experiment, light waves can be made to interfere with each other, and produce either

total darkness or distinct colours, according to the exact nature of the interference which takes place.

Optical experiments show that the light we receive from distant bodies, as from the sun, behaves as if it were composed of a number of rays exactly parallel to each other, while the light received from near objects behaves as if it were composed of rays not parallel, but diverging from a common centre. These facts seem to throw us back upon the conception of really divergent rays, as contradistinguished from parallel rays, and thus would lead us to set us to reject the supposition of strict analogy between the spherical water waves, already spoken of, and the waves of light. We shall, however, find that the difficulty arises from accepting the term "diverging rays," as expressing a literal fact, and not merely affording an approximate illustration.

If we pass from light to gravitation we find another instance of a force moving in straight lines, and varying inversely as the square of the distance at which it operates. Bodies attract each other in proportion to their masses, and the force of that attraction diminishes as the squares of the distances increase. This law is found to hold good for Neptune, the remotest known member of our system, and which, as we have remarked, is more than thirty times as far off the sun as the earth is.

We have as yet no means of showing or establishing a connection between gravitation and other properties of matter. Light, heat, electricity, chemical attraction, magnetism, and mechanical force all stand in a certain relation to each other, and are susceptible of conversion into each other. No one, however, has succeeded in depriving any body of its gravity, and thereby causing the gravitation force to assume a new form. It may be an ultimate and permanent property of matter, or what seems more probable, a property of matter under certain conditions; but we have no idea how it is correlated to other forces which matter exhibits. We have reason to believe that it is propagated in all directions like light, and Newton showed that bodies gravitate towards each other as if their matter were concentrated in one central point, corresponding with what is known as their centre of gravity.

A luminous body emits light, whether or not there is anything which it can illuminate; but we only know of gravitation as a reciprocal action of two bodies upon each other. When a man jumps he kicks the earthball from him with a force proportioned to his own rebound, and if the earth were a little thing, its position would be displaced. As it is, the displacement, though existing theoretically, is too small for appreciation or for computation in intelligible figures. In like manner, when

the earth attracts a falling stone, that stone attracts the earth, but if the stone weighs, or is attracted with a force equal to one pound, and attracts or pulls the earth with equal power, the stone falls, and the earth does not visibly or appreciably rise to meet it, because a one-pound pull at the great globe is practically lost in the ponderous mass.

Electric currents will not traverse the most perfect vacuum we can produce, but light easily traverses any vacuum we can form. Thus we know that it consists of the motion of a more attenuated medium. Gravitation traverses space, and light does the same; but do they do it in the same way? In the case of light there is a transmission of the wave form through the delicate matter which seems to fill celestial space. Is gravitation in any way dependent for its transmission upon this or upon any other form of matter? Could it be stopped, as an electric current can be stopped, by taking away the material particles in space? Or do distant bodies act upon each other with this gravitating attraction without any help from intervening materials? If light be the vibration of ether, its transit must stop if that ether were not present. Does gravitation in any way present an analogy to light? or does it stand alone, having some of the properties of a radiant force, and yet consisting in no motions, and occupying no space for the transmission of its powers?

Whenever we come to ultimate questions we enter into the domain of the unknown. We say light consists of the oscillation of ether particles, each one moving in an extremely minute curve, and stimulating its next-door neighbour to do the same, so that a wave is produced. We are, however, not in the least degree able to explain why such oscillations of particles should produce on our organs the effects of sight. We consider heat as a mode of motion, but we have no idea why a brisk motion of the particles of a candle causes them to burn, or combine with oxygen and give us light. In like manner, if we reduced gravitation to the category of modes of motion, we could not then understand why two bodies should thereby want to come near each other. Nature is full of these mysteries. We trace her facts, and we note their sequence. Our minds, impelled by will, actuated by design, lead us to appreciate the law and order we can discover. We naturally and irresistibly attach to the word *cause* something more than regular but unconnected sequence. As a result of watching the uniformity of natural operations, we form a conception of inevitable and necessary sequence, and we proceed from inevitable and necessary sequence to the assumption of a cause sufficient to make any sequence inevitable or necessary; and, failing to see such cause in the motions of physical particles, we arrive

at the conception of a mental and moral cause adequate to the production of the effects which we observe. A philosophy of science which can rest satisfied that man's most heroic purpose and action is nothing more than an oxydation of particles, can only satisfy a few abnormal minds. Such may be wanted to assist in the process of rigid analysis and investigation, to which they often supply a valuable negative stimulant; but from the earliest times in which speculation existed, down to our own, an overwhelming majority of the greatest intellects have taken another view; and while some have regarded physical forces as merely the exponents of moral and intelligent forces, all have seen in secondary causes the proofs of an ultimate cause; and have regarded the universe not as dead and material, but as spiritual, living and divine.

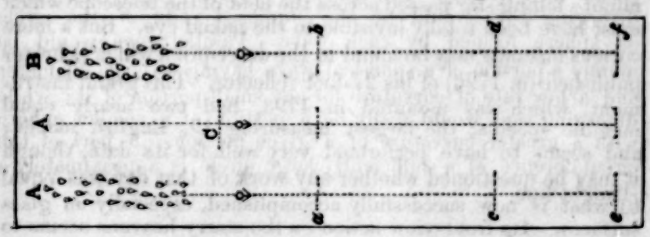
The present paper is put forward tentatively, with a view to promote *thinking* on the subjects to which it alludes. Text books and teachers too often leave students with technical statements, which, although correct, supply only an appearance of knowledge to those who accept them without careful examination. The intricate nature of optical questions, necessitates considerable mathematical knowledge for their complete exhaustion, but the questions started in this paper ought to be susceptible of elucidation, so far as main principles extend, in the language of common life.

Our line of examination seems to show, that if light is presumed to propagate its undulations in concentric spherical waves, it is inexpedient, as well as incorrect, to speak of *diverging* and *parallel rays*. What are called diverging rays would be the supposed radii of the circle or sphere formed by each wave. Parallel rays would be merely a portion of a spherical wave having a large diameter and a low rate of curvature for any small portion of it; while diverging rays would really be a portion of a smaller sphere with a greater curvature of a given portion. A part of the circumference of a sufficiently large circle is approximately a straight line.

SCHRÖTER'S METEORS.—THE LUNAR CASSINI.—CRIMSON STAR.—OCCULTATION.

BY THE REV. T. W. WEBB, A.M., F.R.A.S.

THE examination, in our last number, of Schröter's remarks on Light-spots on the dark side of the moon, naturally leads to a curious observation by the same astronomer, of a very unusual meteoric appearance, with which he closes his chapter on the subject. He tells us that on Oct. 15, 1789, about 5h. 10m. or 15m. A.M., as he was examining the dark side of the moon, then more than 25° high, with a power of 161 in his 7 ft. reflector, and had *Plato* and the *Mare Imbrium*, but no portion of the illuminated hemisphere, in the field;—there and then, in front of the dark globe, and as far as his surprise would allow him to judge, in the centre at once of the *M. Imbrium* and the field of view, broke out in an instant a stream of light, consisting of many separate little sparks, white and brilliant as the enlightened part of the moon. They took a straight course to the N., away in front of the N. part of the *M. Imbrium*, the nearest limb of the moon, and the small vacant remainder of the field. As this stream had completed half its course, another, exactly similar to it in every respect, broke out nearly in the same place where the first appeared, but a little further E., which moved in a line parallel to its predecessor and passed away in the same direction out of sight. He has given a diagram, of which a



reduced copy is inserted here, where A is the 1st, B the 2nd stream, which broke out in B when A had reached C. *a b* being the border of the *M. Imbrium*, *c d* the limb, *e f* the edge of the field.

Startling as was the impression which this distant scene made upon our observer, he soon recovered from it, and repeatedly renewed to himself a lively idea of what he had witnessed in order to compute the time of its duration, when he found that the visible course of each stream had lasted about

2s., and consequently the whole duration of the phenomenon about 4s. (*sic in orig.*) till its final and entire extinction. The circumstances of the observation showed sufficiently that this display could not be referred to the lunar surface, but must have been developed much nearer the earth. The streams were not larger than the representation in the original drawing held 18 inches from the eye, or about 9 inches for our reduced copy, and they caused no perceptible illumination of the field. This was only 9′ in diameter, of which they occupied about half, or 5′, ¼ of the diameter of the moon, and each stream took some 2s. to traverse this little distance. Hence Schröter infers that the meteor was situated at a remoteness from the earth far exceeding the general idea of the extent of our atmosphere. This is not improbable; and it may be thought not unlikely that the observer was actually fortunate enough to catch sight of a portion of one of the meteoric rings which are now believed to intersect at certain times the earth's orbit—the principal difficulty lying in the circumstance that his little sparks were kindled in the middle of the field, instead of coming into sight at its edge. However, if this were so, it would seem to follow that these mysterious bodies are not ignited by the resistance of our atmosphere, but must exist in a self-luminous condition.

Telescopic meteors are uncommon, but perhaps not more so than might be expected considering the smallness of ordinary fields as compared with the extent of the sky. I believe that I have more than once seen something of this nature;—and on one occasion, 1847, Aug. 31, I have expressly noted that a minute falling star passed across the field of the telescope which must have been totally invisible to the naked eye. But a more curious instance may be found in the description which Schröter published (in 1796) of his 27-foot reflector. This grand instrument, which was mounted in 1793, had two nearly equal metallic specula, the largest measuring 19⅛ English inches; and seems to have performed very well for its date, though it may be questioned whether any work of that day was equal to what is now successfully accomplished, especially on glass surfaces. Its front-view action on the starry heavens seems to have been very striking: and though of course not equal in grasp of light to the 40-foot reflector of Herschel I., must have had some little advantage over the more frequently used 20-foot of the same observer. His description of its resolution of the galaxy is interesting. Even in the dark opening near *α Cygni*, he found several little stars; only a tolerably circular space of about 4′ appeared free, yet even in this void he presently detected an extremely minute glimmering point. But on a subsequent occasion the impression of allowing a rich part of the galaxy near the same spot to pass through the field of 15′

of arc, from 6h. 20m. till nearly 8h. P.M. is thus simply recorded—"what Omnipotence!" During that time upwards of 80 fields had passed before his eye; but in not one of them, even the least rich, was he able to number the multitude of stars. Repeated estimation gave him never less than 50 or 60 at once; frequently 150 and upwards; 80 might be considered an average; and this would give 1630 stars per square degree, or 48,900 in an extent of the galaxy 15° long and 2° broad. This estimate gives a close agreement (of course, rather accidentally) with the 50,000 of Herschel I. deduced with the 18-inch aperture of his 20-foot reflector: and hence would follow Two Millions for the whole circle of the galaxy. A more extended comparison led Schröter to think that his telescope would reach upwards of Twelve Millions in the whole compass of the sky. Assuming an equality of reflective power for this speculum, and that of the Earl of Rosse, we should either have for the large telescope of the latter, about 170 millons of stars, or else be obliged to suspect that we had passed

"Extra flammantia mœnia mundi,"

beyond the bounds of visible creation, and were able to gaze out on blank and empty space. And though we have now learned to distrust the formerly current assumption of equality between our sun and those galactic stars, and consequently may conjecture the possibility of a less extended boundary to our telescopic range, yet we cannot help admiring the worthy old Hanoverian when he tells us how the observer is "perpetually finding in the apparently remotest confines of creation new and certain traces of creative power extending itself indefinitely further, and as it were a continually new reflection of the Deity in his great works of nature. In astonishment he here adores Infinite Omnipotence in these wonders, and longs for further and greater discoveries from posterity."

But to return. On June 28, 1795, after examining the more than half illuminated moon with a power of 183 and a field of 15′ in this great instrument, he was looking at a part of the constellation *Ophiuchus*, and noting the continual passage of the minutest stars through the field, 6 or 7 at a time, when an excessively delicate and faint point of greyish light, exactly like a falling star at an extreme distance, passed downwards across the field in about 1 second. It was not brighter or larger than the minute stars in the field, or than those in the galaxy, and smaller than any previously known magnitude, not resembling a meteor in our atmosphere, but probably flying in the expanse of ether; this latter according to the views of Schröter differing only from the atmosphere of the planets in its greater rarity, and the absence of the exhalations arising from the

neighbourhood of each celestial body. This idea, however, of the enormous distance of his meteor was merely an optical impression, and however probable it might be, it would be interesting to test it by calculating at what distance from the earth the average velocity of shooting stars would cause them to traverse 15′ of space in 1s. of time. The data for this are not sufficiently certain to lead to an accurate result, because the speed of individual meteors is very variable, but we may make a rough approximation to it. It appears from Professor Grant's recent observations on the November meteor-shower, that an arc of 60° described in 3s. would represent a great proportion of their courses: taking this as a basis we shall find by an easy reckoning that Schröter's meteor had 80 times less apparent velocity and therefore may be supposed to have been at 80 times greater distance. With every allowance for the uncertainty of such a computation it certainly seems probable that he had reason for supposing that it existed in the depths of space, and that it must have been of a self-luminous character.

We will now, after a long intermission, proceed with our topographical illustration of the lunar surface. The W. extremity of the *M. Imbrium* was called by Riccioli the *Palus Nebularum* and the *Palus Putredinis*, the former lying N.E., the latter S.E., of the No. 16 in our map. These plains are of very level character, and elevations of 250 feet are there of importance, especially in the former, where the terminator forms a clear line, and risings of even 50 feet, if broad enough, could not escape the eye. At the edge of this level, we come upon a very peculiar walled plain, *Cassini* (20), the omission of which from the maps of Hevel and Riccioli led Schröter to the precarious idea that it was of a subsequent date.* How little confidence can be placed in such a negative argument will presently appear, in a smaller but sharply-defined instance. The ring of *Cassini* is very narrow, and lowest towards the four cardinal points, but rises on N.W. to nearly 4400 feet above the plain, the interior being very little, if at all, depressed. I have seen it casting three grand obelisks of shade, two very near together, across the external level. It contains, according to B.

* B. and M. have made it a charge against Schr. that in his anxiety to discover change, he had asserted that *Cassini* was as obvious (augenfällig) as *Aristillus* and *Autolycus*; and they draw attention to the fact that those craters throw shadows visible even in a comet-finder, at a time when *Cassini* would be nearly imperceptible. What Schr., however, actually says is something quite different; viz., that there is no trace of *Cassini* in those two maps, though they contain the neighbouring *Aristillus* and *Autolycus*, which is not so large as *Cassini*, with the yet smaller *Calippus* and *Theætetus*, and the border of the *M. Imbrium*, and that it is not found in the "Phases" of Hevel close to the terminator, though *Autolycus* and *Aristillus* are shown under much higher illumination. *Judicet Lector.*

and M., three small craters; one (A) very deep, precipitous, and conspicuous; a smaller one adjoining it, S.W., and a third close to the S.E. main wall. They speak of having measured A ten times, and their book contains an additional diagram of *Cassini* on a much larger scale, not referred to in the text, but taken apparently with the great Berlin 9·6-inch achromatic, and dated 1836, Sept. 1. And in neither of their delineations, nor in the text, is there the least indication of anything in the interior of A. This might appear conclusive. Yet ten years before that elaborate drawing, and eleven before their description, I had seen something there with a 5-ft. achromatic which I drew and described as a "bright object with shadow, whether central hill, or projection on the declivity, or small encroaching crater, I could not make out." I have since frequently noticed it, and any one may see it even with a small telescope under suitable illumination. I have doubted whether it might be an eccentric hill, or the edge of an interior and deeper crater; but rather inclined to the latter. A sketch obligingly sent me by F. Brodie, Esq., represents it from an 8½-in. object-glass, as a defective wall between two confluent craters. I have not as yet brought to bear upon it the sharp definition of my 9½-in. silvered mirror. Should it be a deeper interior cavity, it might add a third to a rare class, of which two instances are pointed out by Schmidt, where a subsequent eruption has produced a ring contiguous to, but distinct from, that of the more ancient formation.

But whatever may be its nature, we may well ask how it could have escaped the notice of B. and M., especially at the time of a special delineation so minute in detail as to show even a deviation from circularity in the form of A, as well as variations in the height of its ring? So marked an omission in the midst of so much display makes us feel how unsatisfactory it is to argue the question of lunar changes on no other data than those furnished by the most seemingly careful drawings of previous authorities. It is to the labours of such men as Birt and Schmidt that we must look for the solution of this difficulty.

But we have not yet ended the story of *Cassini*. B. and M. have spoken of a second considerably smaller crater enclosed by an imperfect ring, as lying close to the S.W. side of A:—S in the detailed drawing, where it is much smaller in proportion. I have seen what corresponded exactly with this; but further examination has led me to believe that it is not a crater but a mere gorge or hollow on the E. side of the spot where a long buttress, as it were, lies against the S.W. wall of A. This ridge was well seen and drawn by Schr. in 1798, when he also saw two mountains casting shadows outside the N. main

wall, and as he had never seen anything of the kind during the observations of eleven years, he inferred that the former was probably some temporary appearance in the lunar atmosphere, and that the latter had previously been hidden from some similar cause. Here he seems to have been mistaken. The latter —the two mountains, appear in B. and M. and L.: but further from the ring: the former I saw, 1826, May 15, and frequently since, and anybody may see it readily who looks under proper illumination. But if long missed by Schr., it was mistaken by B. and M. for part of a crater-ring; and even their larger drawing does not give its character well, as a ridge gradually ascending till it joins the top of the wall.

On the whole, *Cassini* would form an admirable object for amateur study. Its character is intrinsically interesting; it lies in a very convenient position; it is simple in form and easy of delineation; and though it has been many times meddled with, it has evidently never had complete justice done to it. It should be drawn under many angles of incident light; and not only its morning and evening illumination should be carefully represented, but the peculiar local colouring of its noonday aspect. Such a monograph could hardly fail to be alike improving to the student, and valuable as an addition to "selenotopography."

CRIMSON STAR.

A remarkable specimen of a red star may now be found with little trouble. *Regulus*, or *a Leonis* (which, by the way, though rated 1 mag. seems hardly entitled to the distinction), forms a large obtuse-angled triangle with two attendants: one, η, 3 mag., nearly n; the other, o, 4 mag., considerably further, p a little s. If we now connect these two by a line, we shall find, about $\frac{1}{4}$ of the distance from o towards η, a 6 mag. star, 18, just visible to the naked eye in clear air: a little *sf* this, in the finder, is a small group of four stars, one of which is the crimson star R *Leonis*; so called as being variable, according to Argelander's mode, now generally adopted, of designating such objects by some of the later letters of the Roman alphabet. Its colour is very fine, though not so intense as that of R *Leporis*, with which we hope many of our readers are by this time acquainted.*

In looking at it in a former season, I was struck with a curious effect of contrast in colour. The celebrated binary γ *Leonis* (104 of our list) has just s of it a 6 mag. star, 40. This in the finder had struck me as being of a pale blue verging to lilac, when, on examining it with the $5\frac{1}{2}$-inch achro-

* *Intellectual Observer*, ix. 176.

matic, I was surprised to find it distinctly pale yellow; and, from the intensity of light with the larger aperture, it did not lose this colour even when brought face to face with γ in the large field of the comet eye-piece. Its real tint, then, had been suppressed, in the finder, by the superior strength of the yellow rays of its overbearing neighbour, and even forced into a slightly complementary hue. As I have no reason to think this a peculiarity of my own vision, it may serve to show how much caution must be used in deciding upon the tints of the lesser components of pairs, when the larger is of any decided colour; and this, it seems, will be especially the case in proportion to the apparent smallness, as well as, of course, the closeness, of the pair. For not only is the effect of contrast increased by the juxta-position of the images on the retina, but by difference of brightness, enabling the stronger to force a complementary tint upon the weaker light; and difference of brightness, again, becomes more sensible in proportion to the diminution of the total quantity of light; for it has been remarked by H., that "to any one accustomed to the use of large telescopes, the fact must be familiar, that the apparent inequality of two stars seen at once in the same field of view diminishes as the light of the telescope is greater." Hence it may be conjectured that, could we be gradually transported nearer and nearer to some remote and obscure pairs, where an orange is associated with a much feebler blue companion, we should find the difference of colour decrease as the brightness was augmented, till at length the blue might become white, or even yellow, when liberated from the preponderance of the superior tint. And hence follows the importance of examining suspected star-colours with different apertures, and relying chiefly upon comparisons of observations with the same instrument.

The effect of contrast in colour is pleasingly illustrated by the following anecdote of the late great French painter, Delacroix, related some time ago by Alexander Dumas, at one of his "conferences":—"Delacroix used to tell, that it was while painting *Marino Faliero* that he had discovered his theory of colours. He required for his decapitated Doge and his senators cloaks of cloth of gold, and he had employed to no purpose the most brilliant yellows—his cloaks continued of a tarnished appearance. He determined then to go to the Louvre, to study the works of Rubens, to attempt to steal from this second Titan the fire of heaven. He accordingly charged Jenny, his housekeeper, his manager, his nurse—in a word, his *maitre Jacques*—to go and bring him a cab. Jenny came at the end of a quarter of an hour to tell him that the cab was at the door. Delacroix descended his staircase rapidly, and,

always greedy of time, ran to the vehicle he had ordered. I do not know whether any, among the persons who hear me, may recollect having seen, at this period, canary-yellow cabs—that is, of the fiercest (*la plus farouche*) yellow that can be seen. Delacroix stopped short before the body of his cab; it was a yellow like that which he wanted; but in the position where the carriage was placed, what gave it that dazzling tone? It was not the tone itself, it was the shading which made it come out. But these shadings were violet. Delacroix had no further occasion to go to the Louvre; he paid the cab and went upstairs to his room: he had caught his effect." The observer of double stars may sometimes do well to bear in mind the cab of Delacroix.

On re-examining R *Leonis* with a 9¼-inch silvered glass speculum, by With, 1867, Feb. 2, I found the colour very fine, though the magnitude was much diminished from what I had previously seen. Its variation ranges, according to Pogson, from 5 to 10 mag., with a very irregular period of about 312d. I do not know whether it may now be on the increase or decrease; if the latter, it should soon be looked for, before its colour becomes less striking for want of light. There seem to be only two ways of accounting for the singular colour of these very beautiful and striking objects; reckoning from terrestrial analogies, it might be due either to simple ignition or to peculiarity of composition. There is no antecedent improbability in the former supposition; one sun might as readily exist at a red, as another at a white heat. But it appears to be negatived by the fact, that our terrestrial red-heat is attended by an inferior degree of luminosity, in accordance with its low temperature, hardly corresponding with the vivacity of stellar light. It seems, therefore, more likely that this tint is derived from a peculiarity of elementary composition, which it would be most interesting to ascertain, but which is never likely to be disclosed to mortal research. The colossal reflector of Parsonstown may indeed give so great an intensity to a 5 mag. (the largest attained by any distinctly crimson star), that the spectroscope, which has been recently prepared for it by the skill of Mr. Browning, may be able to effect its analysis; but the probability is, that like our sun through a great extent of its spectrum, it would only exhibit to us a hieroglyphic inscription to which we possess no key.

Occultation.—March 22nd, κ Virginis, 4½ mag., 9h. 28m. to 10h. 17m.

SCHMIDT ON LINNÉ.

EXTRACT from a letter addressed by Herr Schmidt to W. R. Birt, dated Athens, 1867, January 25 :—

"From 1866, October 16th, to 1867, January 24th, I have observed Linné at every opportunity the weather permitted, the result being as follows :—

"1st. In high illumination Linné is *always* as in preceding years, visible as a light spot, somewhat fainter than γ Posidonius. The difference of the sun's height has then no perceptible effect upon its appearance. Not until the sun's height becomes less than 5° is the light spot smaller and fainter.

"2nd. In lower altitudes of the sun and close upon the phase, not only is a crater *never* visible, but there appears in good light, and with magnifying powers from 300 to 600 at most, a very delicate hill of 300 toises (1918·4 English feet) diameter, and five to six toises (between 30 and 40 English feet) in height. As a *crater* Linné has entirely disappeared.

"The *light spot* is *always* visible, but the crater-form has never been visible from October until the present time.

"January 24d. 17h. 18h. Linné had a faint light-tail of a mile (3800 toises or 4·6 English miles) in length, which I had not remarked since October.

"January 25d. 14h. to 16h. Light exceedingly good, decreasing sun height on Linné, now 12° to 13°. *No* crater and the light cloud visible. In it (as on December 26) a very faint black point, to the west of it a fine white summit."

ARCHÆOLOGIA.

WE have the satisfaction of opening this month with the announcement that, by a great act of generous and munificent public spirit on the part of its proprietor, the well-known MAYER MUSEUM has become the property of the town of Liverpool, and, therefore of the nation. The name of JOSEPH MAYER has left a lasting impress on the archæology of this country. In the struggle to raise archæological science from the low condition into which it had fallen half a century ago, which resulted in the establishment of the Archæological Association and the Archæological Institute, Mr. Mayer was an active coadjutor, and from that time to the present he has ever been the first to offer his assistance either in promoting excavations or discoveries or in aiding in the publication of works of historical or antiquarian utility. As an example of what he has done in this latter class of labours, we need only mention the *Inventorium Sepulchrale* of Bryan Faussett,

edited by Mr. Roach Smith, the most important work we possess on the Anglo-Saxon antiquities of the pagan period, and the *Volume of Vocabularies*, which throws so much new light on the antiquities of the middle ages, both costly works, printed entirely at Mr. Mayer's own expense. During now a rather long period of years, Mr. Mayer has laboured in collecting what may truly be called a princely collection of antiquities, at an expenditure of many thousands of pounds, and all English antiquaries of our day will remember with how much interest they visited, and with how much new and interesting knowledge they left, the two large adjoining houses in Colquit Street, which he had fitted up for the reception of his treasures. But for Mr. Mayer's zeal and liberality, the celebrated Faussett collection of Anglo-Saxon antiquities, taken chiefly from the pagan cemeteries of East Kent, and forming one of the most important of our early historical monuments, would probably have been dispersed, while it now forms one of the gems of his collection. He bought, we believe, the collection of antiquities of Mr. Rolf, of Sandwich, the excavator of Richborough (the Roman *Rutupiæ*). Nor is the mediæval portion of the Mayer Museum inferior in importance to that which contains antiquities of an earlier period, and it must not be forgotten that his collection of porcelain, and more especially of Wedgewood ware, is the most perfect in the world. The Egyptian antiquities, and those of the Greek and Roman periods, are also very rich and remarkable. The only condition which Mr. Mayer has placed upon this noble gift to the town of Liverpool is, that it shall be preserved entire, and that it shall always preserve the name of its donor. We can feel no doubt that the town of Liverpool will show its appreciation of the gift, and of the spirit in which it was given, by placing it in a convenient building, and making it as accessible and useful as possible to the antiquarian student and inquirer.

The excavations in the Trevenеage Cave, near Penzance, are still in progress, and we hope shortly to be able to give a more full and complete account of the results. Since we spoke of them last month, the fragments of an earthen vessel, supposed by Mr. Blight to be Roman, have been sent to us, and they are certainly not older than Roman, but, on the contrary, they resemble rather closely the pottery of the early Anglo-Saxon period found in the pagan cemeteries, examples of which will be found in Mr. Roach Smith's *Collectanea Antiqua*, and in other works. Other fragments have been found in the passage in the cave, described in our last, which, as far as we can judge by drawings, are clearly Roman, and there are traces of Roman occupation over the whole of this district. The cave is situated above ancient tin-works; and the valley, which terminates just against St. Michael's Mount, was no doubt in earlier times searched for tin. In the time of Henry VIII., ancient bronze weapons were found here, as recorded by Leland. There is a well-known Roman camp at no great distance, and numerous Roman coins have been found in the locality. Within a quarter of a mile of the cave, there was found, a few years ago, a stone bearing a Roman inscription, built into the wall of St. Hilary Church; the

inscription was read FLAVIO JULIO CONSTANTINO PIO CAESARI DIVI CONSTANTINI PII AUGUSTI FILIO. This, of course, referred to the Emperor Constantine II., or, if the first name may have been mis-read, to Constantius II., whose names were Flavius Julius Constantius. The latter was entrusted with the administration of Gaul at the early age of fifteen, in A.D. 332. We are informed that, in connection with these remains of ancient mines, there are traces of the metal having been smelted on the spot. There were found, among the earth which filled the cave, besides the fragments of pottery already alluded to, large quantities of a coarser kind, portions of iron instruments, a quern, and other articles of stone, with a good flint flake; and also great quantities of charcoal and bones of animals. Amongst the pottery are two or three bits curiously perforated, "as if the cord had been passed through the holes alternately from one side to the other." The cave is surrounded by a great trench, which the excavators are now following up. Mr. Blight adds, in his note, "In a similar cave a few miles distant, a fragment of Samian ware was found two or three years ago, and it is rather curious that fragments of the same ware have been procured from a Scottish Pict's house. These Pict's houses are constructed very much after the manner of the Cornish caves."

The British Archæological Association has just published the full details of the discovery of the ROMAN BUILDING on the shore of GURNARD BAY in the Isle of Wight, drawn up by the Rev. Edmund Kell. It consisted of three rooms, or at least of one middle room and the greater part of two others, at the termination of an ancient road (no doubt Roman) called Rne Street, which runs across the island from north to south. These rooms present the appearance of having formed one side of a court of a larger building, and were evidently rooms for ordinary purposes, as they were rather coarsely paved with small tiles. A good number of Roman coins, with fragments of Samian ware, and other pottery, pieces of building materials, and various other objects, including a mutilated bronze figure of Mercury, were found scattered about. Among other things found here were exhibited a number of small discs of lead, stamped with marks, and with letters, the more numerous examples of the latter consisting of the combination C. T. The circumstances under which these were found seems to suggest the belief, held by Mr. Kell, that they are Roman, and there is nothing about them to urge us very forcibly to a different conclusion. They certainly remind us of the Roman leaden seals, of the same character, which have been found at Brough upon Stanmore in Westmoreland, and at Felixstowe in Suffolk (both the sites of Roman stations), and examples of which have been engraved by Mr. Roach Smith, in his *Collectanea Antiqua*, vol. iii., p. 197. The latter, however, are much less rudely engraved, and present more elaborate designs, with more numerous combinations of letters, than those found at Gurnard Bay; they seem to have been connected with some class of commerce carried on in this distant province during the Roman period with which we are at present totally unacquainted. With the Roman coins at Gurnard Bay were also found a few Greek coins, all of copper.

The presence of Greek coins in ancient Britain appears to be generally regarded by numismatists with great doubt, and one of our most experienced numismatists believes that, as far as they are concerned, this is not a genuine "find." Yet in several instances, as, for instance, at Exeter some years ago, Greek coins are said to have been found under circumstances which do not point to any suspicion of fraud; and we see no reason why, in the course of commerce, Greek coins may not have been frequently brought into our island. On another point, however, we entirely differ from Mr. Kell. We cannot see that this discovery of the remains, probably of a Roman villa, has any connection with the history of the tin trade, or that it furnishes any evidence whatever that the trade of tin from Britain was ever carried through the Isle of Wight; it simply shows that the Romans did occupy this island, a fact of which we had abundant evidence before.

The *Reliquary*, edited by Llewellynn Jewitt at Derby, continues to contribute very worthily its quarterly contribution of good and interesting archæological knowledge. We mention it on the present occasion for the purpose of calling attention to the catalogue of ARCHÆOLOGICAL PRODUCTS OF THE SEA-SHORE OF CHESHIRE, collected during the year 1865, published in the last quarterly number. It has been known for some years that great numbers of antiquities, of all periods, at least from the Roman age, are continually washed up on the beach along the Cheshire coast, from the mouth of the Mersey to that of the Dee, apparently suggesting that a very considerable portion of the space here now covered by sea was at some remote period dry land, which has been gradually washed away. The catalogue to which we allude gives a detailed description of all these objects, to which we refer the reader, and we will content ourselves with merely stating the general character and numbers of the objects of antiquity known to have been thus found during the one year just mentioned. Of flint implements, including a number of arrow-heads, and others of stone and shell, classed under the head of primeval, the number was thirty-three. There were found during the same period twenty-two objects belonging to the Roman period, many of them of rather remarkable character; and an Anglo-Saxon sceatta, with two or three objects in metal, which it is probable may be considered as Anglo-Saxon. The number of objects found on this shore, which are classed under the head of mediæval, is much greater, amounting in all to upwards of a hundred. Among them are a halved penny of the reign of Henry III., and a perfect penny of Edward III.; many pins, needles, personal ornaments of very varied character, pottery, etc., and especially a portion of an equestrian figure in light-coloured and glazed earthenware, belonging to a class of works of art which is excessively rare, and which is generally ascribed to the twelfth century. There were also found —belonging, of course, to a much later period, a silver shilling of James I., a horse-shoe of the seventeenth century, a rowel spur, a large iron ring, and, in all, nearly two hundred heads of clay pipes, ranging from the reign of Queen Elizabeth to the beginning of the last century. We owe the labour of drawing up this curious record of discoveries to Mr. H. Ecroyd Smith.

PROGRESS OF INVENTION.

Economic Fuze for Mining, and other Purposes.—A very simple and inexpensive fuze has recently been invented. It is made by doubling about five inches of thin copper bell wire, which has been coated with gutta percha, twisting about one inch of the looped end, and separating the extremities of the untwisted portions, so that the whole will be in the form of a two pronged fork, of which the twisted part forms the handle. The top of the twisted part being then cut off, the severed portions of the cut end are so near each other, that, when the free ends are connected with an induction coil of very small power, sparks will pass between them. The cut end is then placed in the open extremity of a small oblong capsule formed of very thin sheet lead, and containing a mixture which has been made by triturating ten parts by weight gunpowder such as used for fowling, and one part charcoal made of spindle-tree wood, the mixture having been previously moistened with ordinary collodion. When the cut end of the twisted wire has been inserted in the capsule, the lower edge of the latter is to be fastened to the former, by means of thick gum lac varnish. The smallest spark passing between the cut ends of the twisted wire will ignite the composition in the capsule, and this will ignite any explosive substance in which it may have been placed.

New Galvanic Battery.—The notice of the Academy of Sciences has recently been drawn to a battery of a new kind, which is said to have acted extremely well, for electrotype purposes, during several months. It is founded on the fact that aqua regia will not dissolve perfectly pure silver; it merely covers the silver with a thin coating of chloride, that protects it completely from further action, so that it may be immersed for an indefinite period in the aqua regia, without undergoing further change. If the silver contains copper, or the aqua regia has been made with an excess of nitric acid, or even with equal quantities of nitric and hydrochloric acids, the silver will, to a greater or less extent be changed into a chloride. Two-thirds hydrochloric and one-third nitric acid, or three-fifths of the former and two-fifths of the latter were found to answer well. The battery was a Grove-Bunsen formed of silver, aqua regia, zinc, and sulphuric acid diluted as usual. After having been in action for some months, the silver was not found to have lost any perceptible weight, nor was there any chloride in the porous vessel containing the silver and aqua regia.

A Very Simple Electrical Machine.—This machine is an improvement on that of M. Holtz. It consists of a disc of strong paper, 30 centimetres in diameter, mounted on an axis made of glass tube or some other non-conducting material, and capable of being made to revolve about fifteen times in a second, by means of wheels, an endless band, and a handle. In front of the disc are two metallic rods having pointed extremities which are perpendicular to the disc, being turned towards it, and at equal distances from its centre. The remaining portions of the rods are bent perpen-

dicularly, one up and the other down, so that the metallic balls on their other extremities may be at an adjustible distance from each other. The apparatus is charged by placing a sheet of paper that has been well dried at the fire and electrified by friction, very near, but not in contact with the disc, opposite to one of the pointed collectors, but not at the same side of the disc. On turning the machine, a luminous jet will pass between the balls. If the disc is covered with gum lac, and sheets of paper oppositely electrified are placed opposite the points of the collectors—one sheet being opposite to each collector—the intensity and duration of the effects obtained will be greatly increased. When the experiment is carefully made, sparks, five centimetres in length, will pass between the balls, and a Leyden jar, the coatings of which are connected, respectively, with the latter, will be charged with great rapidity.

LITERARY NOTICES.

DIARRHŒA AND CHOLERA; their Nature, Origin, and Treatment, through the Agency of the Nervous System. By JOHN CHAPMAN, M.D., M.R.C.P., M.R.C.S. Second Edition, enlarged. (Trübner and Co.)—We have on a former occasion mentioned Dr. Chapman's treatment of cholera by the application of ice-bags to the spine. He founds this practice upon a theory which is at any rate plausible; and as medical treatment of this terrible disease has in the main proved a lamentable failure, he is entitled to make a strong demand for the trial of his plans. Diarrhœa and cholera he regards as substantially the same disease, arising from over-excitement of nervous centres, and remediable by diminishing the action of the particular nerves supposed to be over-stimulated. He is as unable as other members of his profession to give us any intelligible account of how and why excessive heat, great changes of temperature, impure water, etc., combine to generate cholera in some seasons more than others; but he has brought together a considerable mass of information which tends to increase disbelief in the value of the ordinary treatment, if it does act with equal power in creating faith in ice. Opium, stimulants, calomel, and sulphuric acid are among the agents which Dr. Chapman considers positively mischievous. The effect of the ice treatment applied to the *spine only* is illustrated by numerous cases, and when accompanied by warm drinks, is affirmed to have been highly successful. The question is, has Mr. Chapman, in his zeal as a supposed discoverer, exaggerated the merits of his nostrum? We look to the medical world to answer this query by authentic cases, and a fair comparison of different methods. If Dr. Chapman is wrong, let his theory go the way to oblivion which previous errors have traversed—if right, let society have the benefit of it, whatever may be its consequences to medical orthodoxies.

RESEARCHES ON SOLAR PHYSICS. By WARREN DE LA RUE, ESQ.,

Ph.D., F.R.S., F.R.A.S.; Balfour Stewart, Esq., M.A., F.R.S., Superintendent of the Kew Observatory, and Benjamin Loewy, Esq., Observer and Computer of the Kew Observatory. Second Series (in continuation of First Series). Area and Measurements of the Sun Spots, observed by Carrington during the seven years from 1854 to 1860 inclusive, and deductions therefrom. (Taylor and Francis.)—To verify the observations of Carrington by comparing them where practicable with the Kew photograph was one part of the labours which are recorded in the "Second Series" of the *Researches on Solar Physics*, and then to ascertain what indications they afforded of the laws regulating the appearance and distribution of spots. The authors have constructed an elaborate table showing the proportion which the spotted area bore to the solar surface for each day on which an observation could be made between 1854 and 1860 inclusive. Another inquiry related to the distribution of spots on the disc of the sun, and from this it appears that the "average size of a spot varies with the ecliptical longitude, and there is a periodical recurrence in their behaviour, and the period of recurrence of the same behaviour appears to be nineteen or twenty months." "In all these recurrences the progress of the maximum is from left to right, not from right to left." "The period of twenty months," say the writers, will enable us to determine which of the inferior planets exercises the predominant influence on sun spots. We have to ask which of the two inferior planets takes twenty months to return to the same position with respect to the earth. This evidently points to Venus, for which the synodical period is 583 days, or between nineteen and twenty months." Jupiter appears also to affect the spots, and when both that planet and Venus are in opposition to the earth, large spots appear, and the average seems smaller when Venus is in opposition and Jupiter in conjunction. With reference to the position of the spots, "it would appear that spots are nearest to the solar equator when the heliographical latitude of Venus is 0°, and are most distant from the solar equator when the planet attains its greatest heliographical latitude."

The writers remark, "it is not to be inferred that the mechanical equivalent of the energy exhibited in sun spots is derived from the influencing planet, any more than it is to be inferred that the energy of a cannon ball is derived from the force with which the trigger is pulled. The molecular state of the sun, just as that of the cannon or of fulminating powder may be extremely sensitive to impressions from without. We may infer from certain experiments, especially those of Cagniard de Latour that at a very high temperature, and under a very great pressure, the latent heat of vaporization is very small, so that a comparatively small increment of heat will cause a considerable mass of liquid to assume the gaseous form, and *vice versa*." From the preceding remarks and extracts it will be seen that the Second Series of *Solar Physics* is of high value. Is not their title awkward? "Researches *on* Solar Physics." We search *into* a matter. A search or research *on* the earth would be a search conducted *upon* it, not necessarily one into its elements or composition.

PROCEEDINGS OF LEARNED SOCIETIES.

GEOLOGICAL SOCIETY.—*December* 19, 1866.

The following communication was read:—

On a new specimen of Telerpeton Elginense. By Professor T. H. Huxley, LL.D., F.R.S., V.P.G.S.—The specimen which was described in this paper had been broken into five pieces, exhibiting hollow casts of most of the bones of *Telerpeton Elginense*. It is the property of Mr. James Grant, of Lossiemouth, and came from the reptiliferous beds of that locality, along with some highly-interesting fragments of *Stagonolepis* and *Hyperodapedon*.

In describing these remains, Professor Huxley discussed especially the biconcave character of the vertebræ; the mode of implantation of the teeth, which he believed to be Acrodont, and not Thecodont; and the anomalous structure of the fifth digit of the hind foot, which presents only two phalanges (a proximal and a terminal), a structure which differs from that of all known Lacertilian reptiles, whether recent or fossil. His researches had led him to conclude that the animal is one of the Reptilia, and is devoid of the slightest indication of affinity with the Amphibia. In all its characters it is decidedly Saurian, and accords with the suborder *Kionocrania* of the true Lacertilia; but the author had not been able to make sure that it possessed a columella. He also remarked that the possession by *Telerpeton Elginense* of vertebræ with concave articular faces does not interfere with this view, as although most recent Lacertilia have concavo-convex vertebræ, biconcave vertebræ much more deeply excavated than those of *T. Elginense* are met with among the existing Geckos.

Professor Huxley, in conclusion, drew attention to the interesting fact that *Telerpeton* presents not a single character approximating it towards the type of the Permian *Protorosauria*, or the Triassic *Rhynchosaurus*, and other probably Triassic African and Asiatic allies of that genus, or to the Mesozoic Dinosauria; and that whether the age of the deposit in which it occurs be Triassic or Devonian, *Telerpeton* is a striking example of a *persistent type* of animal organization.

NOTES AND MEMORANDA.

Tempel's Comet and Shooting-Stars.—Dr. Peters, of Altona, writing in *Astronomische Nachrichten*, points out the close resemblance between the orbits of the August and November meteors, and that of Tempel's comet. He states that further observation is necessary to show whether this comet really belongs to that system of small bodies, and remarks that it is distinguished from other comets of short periods by its retrograde motion.

Faye on the Sun's Rotation.—*Comptes Rendus*, No. 5, 1867, contains an elaborate paper founded on Mr. Carrington's observations. He arrives at the following conclusions:—"1. The retardation of the rotation of the photosphere from one parallel to another is proportional to the square of the sine of the latitude. 2. The constant of the parallax of depth applicable to observations of

spots is 0°·41: the depth of the spots is the shene of 0°·30 or of 0°·57 the radius of the earth. It is constant through the whole extent observed between +30° and −30° of latitude. 3. Spots have a pendulum-like oscillation in latitude: the period of these oscillations varies with the latitude, and appears to reach a maximum of 150 to 160 days about the 14th degree. At 15 degrees from that point it seems reduced about one-half. 4. Spots have an oscillating motion in longitude corresponding with the same period, and the geometrical combination of these movements operates as if the spot described in the direction of the rotation an ellipse about its mean position, with its major axis directed from one pole to the other. This singular rotation appears to have a direct connection with the internal constitution of the sun."

MR. WRAY'S OBJECT GLASSES.—Mr. Wray, of Clifton Villas, Highgate Hill, recently brought before the Astronomical Society an account of his plans for correcting the secondary spectra in object-glasses. He interposes "a thin meniscus film of highly dispersive cement" between flint and crown glasses, and thus obtains a perfect achromatic image.—*Monthly Notices*, January.

PHANTOM THUMBS.—If any one looks steadily at a patch of moderately bright light on a wall, and then gradually raises his hands, having the fingers shut, the palms directed forwards, and the two thumbs touching at their tips, he will at the moment the thumbs reach the level of the eye, see *three* thumbs instead of two. The eyes should be directed steadily at the wall all the time, and not attempt to look at the thumbs. Some persons see the illusion best when the thumbs are within a few inches of the eye, and others do so when they are held away at arm's length. Curious effects are produced by slowly separating the thumbs as they reach the eye-level, and also by substituting fingers for thumbs.

BEES' EGGS AND THEIR PRODUCTS.—M. H. Landois, in *Comptes Rendus*, recites experiments he made to test the truth of the proposition laid down by Dzierzon and Von Siebold that working bees are hatched from eggs which the queen fertilizes with sperms from her *receptaculum seminis*, while male bees issue from eggs not so fecundated. By carefully removing eggs from cells destined for the workers to those of the males, and *vice versa*, he altered the nature of their inmates. Thus, he says, the difference of the food supplied to the inhabitants of the two kinds of cell determines whether they will be males or workers.

PLATEAU'S LIQUID.—For blowing the large persistent bubbles and exhibiting experiments with films, M. Plateau states that pure oleate of soda dissolved with gentle heat in distilled water, in about 40 of water, and then mixed with Price's Glycerine, in the proportion of 3 parts of the oleate to 2·2 glycerine, gives the best results. The mixture is fit for use one or two days after it has been made. Bubbles blown with this liquid have lasted longer than twenty-four hours. The fluids usually sold in London for these experiments are great rubbish. Some respectable chemist should prepare the pure oleate.

BOILING WATER IN ROTATION.—M. Mousson wished to keep some water boiling for several hours in a large glass globe with a flat bottom holding about three *litres*, and heated with gas. The ebullition was weak, although facilitated by copper turnings unequally distributed over the bottom of the vessel. Occasional vapour bubbles preserved their dimensions uniform in their passage through the liquid, showing the equal distribution of the heat. In order to make the copper turnings assemble together above the flame he caused the vessel to rotate. This immediately gave rise to an energetic whirlpool movement about the axis of rotation, a sort of water column eight to ten millimetres in diameter revolving rapidly, carrying up multitudes of copper particles. In the midst of this column was a constant disengagement of small bubbles, closely approximating, and making a momentary canal one millimetre in diameter. No bubbles proceeded from other parts of the liquid. *Kleine Physic, Mittheil. Archives des Sciences.*